Metal Detectors and PPE Catalogue

2005

Geneva International Centre for Humanitarian Demining
Centre International de Déminage Humanitaire - Genève

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The **Geneva International Centre for Humanitarian Demining** (GICHD) supports the efforts of the international community in reducing the impact of mines and unexploded ordnance (UXO). The Centre is active in research, provides operational assistance and supports the implementation of the Anti-Personnel Mine Ban Convention.

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Metal Detectors and PPE Catalogue 2005, GICHD, Geneva, February 2005.

ISBN 2-88487-024-5

The description of the detectors and the test results expressed in this catalogue are those of the manufacturers. They do not necessarily represent the views of the Geneva International Centre for Humanitarian Demining (GICHD) or the Government of Germany. The views expressed in this publication are otherwise those of the GICHD and do not necessarily represent those of the Government of Germany. The designations employed and the presentation of the material in this publication do not imply the expression of any opinion whatsoever on the part of the Government of Germany or the GICHD concerning the legal status of any country, territory or area, or of its authorities or armed groups, or concerning the delimitation of its frontiers or boundaries.

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Acknowledgements

This report was researched and written by Lieutenant-Colonel Johannes Dirscherl, Mechanical Studies Specialist, GICHD. Assessment of detection technologies (*see Annex 1*) was researched and written by Dr. Claudio Bruschini.

The report was edited and laid out for publication by Françoise Jaffré.

All photographs have been provided by the respective manufacturers.

Foreword

The last few years have seen the emergence of many new technological approaches to simplifying and speeding up the clearance of landmines and unexploded ordnance (UXO). Nonetheless, the manual deminer, equipped with hand tools and a metal detector, remains the most standard method of humanitarian demining. The metal detector will, for many more years, provide the main means of mine and UXO detection.

The GICHD's 2005 *Metal Detectors and PPE Catalogue* provides information on most detectors currently available to the humanitarian mine clearance market. Not all manufacturers have contributed to the Catalogue. Some that did contribute were unable to provide sufficient information about their product to be included in the publication. Therefore, a number of metal detectors being used in the field are not featured.

Independent performance tests on metal detectors are relatively few in number. The GICHD itself does not carry out testing and evaluation, but those interested in detectors that have undergone tests should contact manufacturers directly, or, in some cases, refer to the European Union's Joint Research Centre (JRC) website. The JRC conducted comprehensive detector trials in Laos in December 2004 using the newly established CWA (CEN Workshop Agreement). The results were not available in time to be included in this publication.

The 2005 *Metal Detectors and PPE Catalogue* includes an annex giving information on various detector technologies currently in development. This gives a rough overview on the state of research, and indicates possible future solutions.

The Catalogue features a chapter on personal protective equipment (PPE). Once again, not all manufacturers of PPE used in humanitarian demining are featured here. Currently, no standard test system exists for demonstrating the effectiveness for a particular item of PPE.

The Catalogue is available in hard copy, CD-ROM, or can be viewed by visiting the GICHD website at *www.gichd.ch*. The information provided is accurate as of 1 December 2004. If changes in a product have occurred, manufacturers' updated information will be included on the GICHD website.

The GICHD would like to thank the Government of the Federal Republic of Germany for its generous financial support to this project.

Ambassador Stephan Nellen
Director
Geneva International Centre for Humanitarian Demining

Section 1

Hand-held detectors

CEIA MIL-D1

CEIA, Italy

MIL-D1 is in service with military and humanitarian demining units

Transport case

General description

The **MIL-D1** is a portable, high-sensitivity metal detector designed to detect all metals in conductive and non-conductive soils, including laterite. The metal detector consists of a detection head, a telescopic handle, an electronics unit, a canvas carry-bag and a high-impact polypropylene case. The detection head is light, and the wiring is protected from any damage. The electronics unit can be carried over the shoulder, attached to the belt, or as an integral part of the telescopic handle. According to the manufacturer the MIL-D1 metal detector does not require any daily manual calibration; optimum sensitivity is ensured over all types of terrain due to CEIA's Automated Soil Compensation System. The detector is manufactured in compliance with the ISO 9001 standard, and has been designed to satisfy the most stringent operational requirements for both humanitarian and military demining.

A backlit LCD display on the control panel is available as an option.

A hand-held remote programmer allows MIL-D1 flash memory upgrades under any conditions. MD Scope software for PCs is available for troubleshooting and annual verification of MIL-D1 calibration.

Working methodology

Localisation of metal objects is optimised by a two-tone audible pinpointing system, which allows the position of the detected mass to be identified accurately. When the metal detector approaches a metal mass, the system produces a signal of acoustic intensity proportional to the metal mass. The metal mass is pinpointed at the position of the centre of the search head at the moment the audible signal tone changes.

The audible signal is transmitted either through an internal speaker or external monoaural headphone.

CEIA's Automated Soil Compensation System ensures an above-average sensitivity in all types of soil. The detector, during soil compensation (conducted prior to the search operation), uses digital processing of the electromagnetic response from the target soil to determine the most

effective strategy. The presence of water does not affect the performance of the detector. Soil compensation capability covers all different soils.

Power supply

- 4 x 1.5V alkaline batteries or 4 x 1.2V Ni-MH rechargeable batteries (available on request);
- 65 hours with alkaline batteries at 20°C;[1]
- 50 hours with alkaline batteries at 5°C;[1]
- 35 hours with Ni-MH rechargeable batteries (7000 mA) at 20°C.

Detectors in use to date

The detectors are in service with various aid organisations, commercial mine clearance companies and armed forces in the following countries: Afghanistan, Angola, Bosnia and Herzegovina, Croatia, Denmark, Djibouti, Egypt, Ethiopia, Finland, France, Iraq, Italy, Japan, Lebanon, Mozambique, Namibia, Spain, Sri Lanka, Sudan, Sweden, Switzerland, Thailand, Turkey, the US, Venezuela, and Yemen.

Factory support

- The proposed spare parts package is arranged in accordance with a life-cycle management study and CEIA experience as the original manufacturer;
- An extensive programme is available for both operators and maintenance personnel;
- Factory-based training is included in the purchasing package;
- Instruction manuals and documentation are provided in Arabic, English, French, Italian, Portuguese, and Spanish. Other languages are available on request;
- The standard warranty is two years. Extended warranty periods can be arranged on request;
- Comprehensive factory follow-up includes services via Internet contact, mail and personal contact;
- On-site training, supply of training aids, diagnostic software, portable remote programmer;
- Other services provided by the manufacturer include software upgrading, comprehensive technical assistance, mine simulant study and manufacturing.

Maintenance and support

The detector is considered user-friendly and the customer can completely maintain the equipment. It is not necessary to return the unit to the factory for troubleshooting or verification of calibration. MIL-D1 electronics board is based on full digital technology, which means there is no requirement to trim or refine the performance using laboratory equipment.

Test and evaluation

- The MIL-D1 has been subjected to extensive testing (in terms of detection reliability and capability) by UNOPS and several ministries of defence and humanitarian demining organisations.
- The detector went through the following comparative trials: UNDP/UNOCHA test Afghanistan, September 1999-March 2000; Gruppe Rüstung (Swiss Army), August 2001; UNOPS test Afghanistan, February-March 2002.
- The detector has recently been tested by JRC in Laos but no detailed information is yet available. However, it will be soon published on the JRC website

Reported limitations and strengths

Limitations	*Strengths*[2]
▪ The test reports mentioned above do not point to major limitations.	▪ Far above the average detection rate. ▪ Ease of operation. ▪ Ease of maintenance.

1. Gruppe Rüstung, *Technische Erprobung von Minensuchgeräten*, Pieren Jakob, FS 263, Beilage 1, p. 2.
2. UNOPS, *Summary of Metal Detector Trial Report*, February - March 2002.

Ebinger EBEX® 420 H-Solar

Ebinger GmbH, Germany

The EBEX® 420 H with its integrated solar panel

General description

The hand-held mine detector **EBEX® 420 H-Solar** is an evolution of the EBEX®420 and was designed to support One-Man-One-Lane mine clearance drills. It is a single piece tool without external boxes or cables.

Main characteristics:

- The equipment is designed for easy assembly and operation;
- Highly sensitive to minimum-metal mines like the MAI 75 and R2M2;
- Little user maintenance is required;
- Powered by solar panel.

Working methodology

The EBEX® 420 H applies the very sensitive Ebinger sine wave system and detects metal components including wires by an electromagnetic field of low frequency. A special effort was made to achieve a good resolution of several mines buried at close distance either to each other or to other interfering metal.

The new EBEX® 420 H metal detector was designed for the location of landmines containing only a minimum amount of metal, or buried UXO. The detector electronics was fully integrated into the handle. EBEX® 420 H can be used in a short mode of approximately 0.6m length for searching in the prone position. For use in the standing position an extension rod takes the detector length to 1.2m. Its simplicity in operation and the absence of cable-linked components make it ideal for the single-operator clearance drill.

Detectors in use to date

The EBEX® 420 H is in service in 26 nations including: Afghanistan, Angola, Cambodia, El Salvador, Guatemala, Kuwait, Lebanon, Mozambique, Nicaragua and Somalia.

Since 1998, more than 2,100 units of EBEX® 420 H have been sold. This detector is in use with various humanitarian demining organisations, the United Nations and many other commercial companies.

Power supply

- The EBEX® 420 H is powered by 1 x 9V U9VL LR61 or alternative; rechargeable battery 9V LR61;

- Operational life of battery (1 x 9V alkaline 600mA/h): approx. 45 hours[1] (without solar radiation);
- Operational life of battery pack (9V 110mA/h): approximately 20 hours[1] (without solar radiation).

Factory support

- All detectors are covered by a 24-month warranty. The worldwide service network ensures permanent availability of spare parts;
- Operation and maintenance training is provided at Ebinger facilities or on site;
- Additional factory support by specially trained staff is provided on request;
- Instruction and maintenance manuals are available in Arabic, English, French, German, Italian, and Russian, and other languages on request.

Maintenance and support

- There are no special requirements for the technicians or workshop facilities. Most repairs can be carried out by Ebinger-trained staff on site.
- The step-by-step explanations in the manuals help to ensure easy maintenance of the system.

Test and evaluation

The detector went through comprehensive internal tests. Reports displaying the performance can be provided by the manufacturer on request.

EBEX® 420 H in operation

Reported limitations and strengths

The system has been in service for several years, but has not yet been tested in comparative trials. Therefore, no statement regarding known limitations and strengths can be given.

1. According to the manufacturer.

Ebinger EBEX® 420 PBD

Ebinger GmbH, Germany

EBEX® 420 PBD in operation

General description

The **EBEX® 420 PBD** is a modular, easy-to-use piece of equipment, which is in daily use in Afghanistan, Angola, Bosnia and Herzegovina, Cambodia, El Salvador, Georgia, Mozambique, Viet Nam, and Zimbabwe, as well as other mine-affected countries. The detector design eases logistics and maintenance, allowing fault identification and remedy without tools and advanced training.

Main characteristics:

- The equipment is designed for easy assembly and operation;
- High sensitivity enables detection of low-metal-content mines;
- Good adaptation to conductive soil, good pinpointing and fast work progress;
- The equipment's large dynamics in the audio alarm system helps operators to discriminate small from large metal items;
- The equipment's audio control pulses indicate the battery condition. Audible confidence clicks inform operators that equipment is functioning correctly;
- The equipment operates on a dynamic search mode;
- The equipment widely filters interference from conductive ground or salt water;
- Little user maintenance is required, saving time and expense.

Working methodology

The EBEX® 420 PBD hand-held mine detector is the pulse induction version of the EB 420. It was developed in cooperation with military personnel serving in the United Nations and humanitarian mine clearance operations around the world. It is intended to suit large scale mine and battle area clearance in adverse conditions and requires only minimal training and logistic support.

The detector operates with the dynamic Ebinger pulse induction system. Its search head sends out short magnetic pulses which cause conductive targets to respond with an electromagnetic echo field which is detected and transduced into an audible signal. The intensity and characteristics of the signals depend on the size and distance of the detected target. The dynamic search mode adapts the detector to homogene soil interference and provides a good resolution between several targets buried at close distance.

The EBEX® 420 PBD was designed to locate low-metal-content mines and to detect UXO hidden in undergrowth or buried underground. Its simplicity of use by one adjuster makes it ideal for deployment in adverse conditions or in difficult operations.

It is lightweight with the electronics integrated into the handle. This negates the need for cables and additional control boxes or a battery compartment and the detector can even be operated with a loudspeaker.

The EBEX® 420 PBD can be operated in a short mode of approximately 1m for search in the prone position or in the extended version of 1.6m when used in the standing position. Its large dynamics and wide adjustability will facilitate the suppression of interference from conductive ground.

Detectors in use to date

Since 1995, more than 5,000 EBEX® 420 PBD detectors have been sold. They are in use with various humanitarian demining organisations, the United Nations and many commercial companies.

Power supply

- The EBEX® 420 PBD is powered by 6 x 1.5V C-cell or alternative; rechargeable battery pack 3.8 A/h, 12V;
- Operational life of battery (6 x 1.5V alkaline 8A/h): approx. 50 hours,[1]
- Operational life of battery pack (12V 3.8A/h): approx. 35 hours.[1]

Factory support

- All detectors are covered by a 24-month warranty. The worldwide service network ensures permanent availability of spare parts;
- Operation and maintenance training is provided at Ebinger facilities or on site;
- Additional factory support by specially trained staff is provided on request;
- Instruction and maintenance manuals are available in Arabic, English, French, German, Italian, Russian, and other languages on request.

Maintenance and support

- There are no special requirements for the technicians or the workshop facilities. Most repairs can be carried out by Ebinger-trained staff on site;
- The step-by-step explanations in the manuals help to ensure easy maintenance of the system.

Test and evaluation

The detector has passed several tests: UNAVEM III Demining School – Commander (Memorandum) 1996; International Detector Test UNADP Mozambique, December 2000; European Commission Directorate General JRC,[2] March 2001.

Reported limitations and strengths

The detector has been through a number of trials, however, no general scientific evidence is available regarding detection performance under different soil conditions or other key qualities.

It showed the capability to detect a VPROM1 with a sufficient safety margin at all angles.[2]

1. According to the manufacturer.
2. M. Fernandez, A. Lewis, F. Littmann, *PROM 1 Anti-personnel landmines - Probability of activation by physical contact with a metal detector*, Special publication No. I.01.29, European Commission Directorate General JRC Joint Research Centre Institute for Systems, Informatics & Safety, Ispra, March 2001.

Ebinger EBEX® 421 GC

Ebinger GmbH, Germany

EBEX® 421 GC in operation

General description

The **EBEX® 421 GC** is a modular, compact, lightweight, battery-operated, hand-held metal detector which is suitable for all kinds of demining operations. The modular design ensures that each component is interchangeable with other detectors of the same "family". Each component can be ordered individually. The EBEX® 421 GC is the enhanced version of the EBEX® 420 GC. The system is able to detect mines with minimum metal content to a high level of reliability and can be used in both shallow fresh or salt water.

The rugged design qualifies the detector to be used under all climatic conditions.

Main characteristics:

- The equipment is simple to set up and easy to operate;
- The equipment can compensate unhomogeneous laterite or mineralisation maintaining high detection sensitivity;
- The equipment's large dynamics in the audio alarm system helps operators to discriminate small from large metal items;
- The equipment's audio control pulses indicate the battery condition. Available confidence clicks inform operators that equipment is functioning correctly;
- The equipment operates on a dynamic search mode;
- The equipment widely filters interference from conductive ground or salt water;
- Little user maintenance is required, thereby saving time and expense.

Working technology

The EBEX® 421 GC uses bipolar pulse induction for detection and is designed to operate in high metallic soils by including a soil compensation feature.

No further detailed information is given by the manufacturer.

Detectors in use to date

Since 1998, more than 2,500 EBEX® 420 GC detectors have been bought. They are in use with various humanitarian demining organisations, the United Nations, and many commercial mine clearance companies.

Power supply

- The EBEX® 421 GC is powered by 8 x 1.5V C-cell or alternative; rechargeable battery pack 3.8 A/h, 12V;
- Operational life of battery (8 x 1.5V alkaline 8A/h): approx. 20 hours;[1]
- Operational life of battery pack (12V, 3.8A/h): approx. 10 hours.[1]

Factory support

- All detectors are covered by a 24-month warranty. The worldwide service network ensures permanent availability of spare parts;
- Operation and maintenance training is provided at Ebinger facilities or on site;
- Additional factory support by specially trained staff is provided on request;
- Instruction and maintenance manuals are available in Arabic, English, French, German, Italian, Russian, and other languages on request.

Maintenance and support

There are no special requirements for the technicians or the workshop facilities. Most repairs can be carried out by Ebinger-trained staff on site.

The step-by-step explanations in the manuals help to ensure easy maintenance of the system.

Workshop in Mozambique: local demining personnel repairing mine detectors

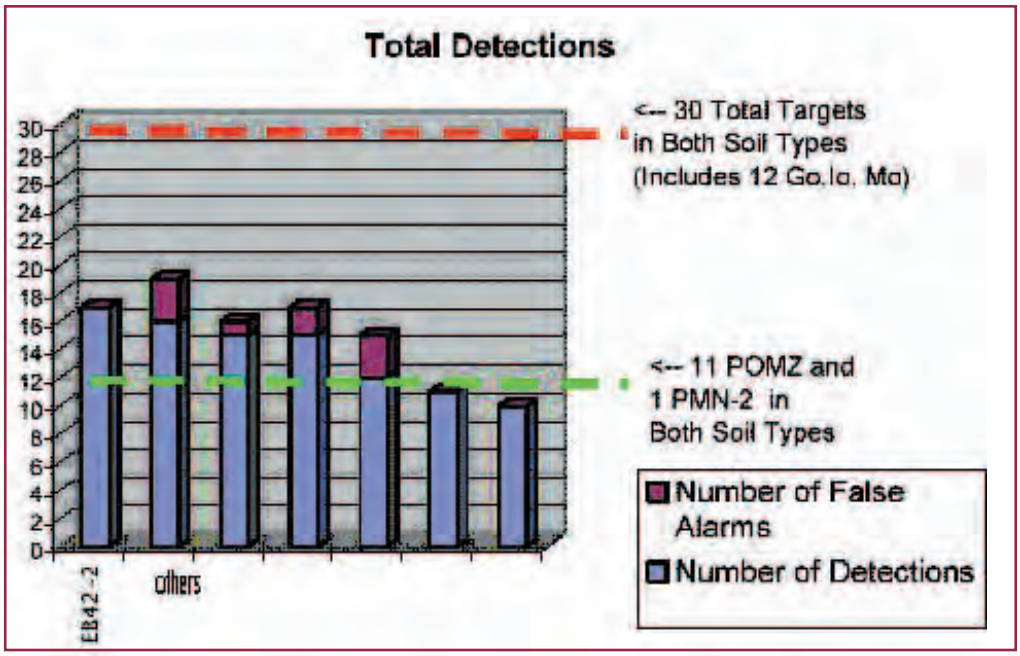
Test and evaluation

The detector went through comprehensive internal and comparative tests (in terms of reliability and capability of detection).

Due to the identical working methodology and technical specifications the EBEX® 420 and 421 GC do not differ from each other in terms of capability of detection.

Tests passed by the detector (EBEX® 420 GC) include:

- Nicaraguan Field Test Report, 2001 (EBEX® 420 GC);
- International Pilot Project for Technology Cooperation (IPPTC), 2001 (EBEX® 420 GC);
- International Detector Test, UNDP Yemen, 2002;
- UN Mine Action Programme Afghanistan, February-March 2002 (EBEX® 420 GC);
- US Department of Defense Humanitarian Demining Research and Development Program, Nicaraguan Field Test Report, October 2001, p. 15.
- The detector has recently been tested by JRC in Laos but no detailed information is yet available. However, it will be soon published on the JRC website.



Nicaraguan Field Test Report, October 2001.[3]

Reported limitations and strengths (related to EBEX® 420)[2]

Limitations

- Poor range of length adjustment.
- Front heavy in long configuration.
- Soil compensation adjustment screw is unlabelled and difficult to use.

Strengths

- Good auditory output devices – volume control on headset and external speaker (optional).
- Easy set-up and operation.
- Rugged and waterproof.

1. According to the manufacturer.
2. Y. Das, J.T. Dean, D. Lewis, J.H.J. Roosenboom, G. Zahaczewsky (eds), *A multi-national technical evaluation of performances of commercial off the shelf metal detectors in the context of humanitarian demining*, International Pilot Project for Technology Co-operation, Final report, European Commission, Joint Research Centre, Ispra, Italy, 2001, p. 64.
3. US DoD Humanitarian Demining Research and Development Program, *Handheld Metal Detectors - Nicaraguan Field Test Report*, October 2001, p. 15.

Foerster MINEX 2FD 4.500

Institut Dr. Foerster, Germany

Minex 2FD 4.500 in operation

General description

The **MINEX 2FD 4.500** is a metal detector working on the continuous-wave EMI principle with two parallel frequencies. Production started in early 2000 and the detector is being used in a variety of demining scenarios with army and police forces, NGOs and commercial companies. One of the MINEX's most obvious features is its one-piece design. This is intended to ensure a high speed of operation, very low and precisely-balanced weight, high mechanical durability, and a minimum of potential mechanical "weak points" such as cables or plugs.

A drill-safe telescopic bar with fast-lock clips keeps the search head in its chosen position.

The MINEX 2FD 4.500 is equipped with a push button for ground-learn procedure to ensure adaptability to all soil conditions. Under special circumstances, the internal electronics can be adapted and optimised for search in a particular area over longer periods.

Safety considerations strongly influenced the MINEX development. An audible alarm informs the operator of any malfunction. Low battery level is indicated by a red LED, guaranteeing hours of safe work without any loss of sensitivity. When remaining battery life reaches a critical point, an additional audible alarm is activated. Double safety is ensured by a steady ticking sound during operation. The search head does not need to be moved in order to get a signal, so keeping the head motionless over an object will not result in a drop in signal level.

A number of other, less obvious features are included to optimise user safety. As the detector covers a variety of different frequencies, all metals can be found with roughly the same sensitivity. In addition, preset sensitivity will be maintained even if the soil is compensated. The electronics are programmed not to modify the sensitivity level without the user's knowledge.

Working methodology

The MINEX 2FD 4.500 has three possible sensitivity settings, which are placed on the back of the detector, allowing a supervisor located behind the user to identify the chosen setting. Working on a non-dynamic principle, there is no minimum speed for coil movement.

The gradiometric arrangement of the search coil indicates metallic objects with a switching sound when the centre of the coil passes over them. As a result, it is possible to pinpoint objects exactly; to distinguish objects located very closely together; and to work beside large metallic objects, such as fences, railways and gates.

As an example, minimum-metal mines located in a horizontal distance of about 10-15cm from each other can still be separated and localised. The only steady background noise is an unobtrusive control tick.

Water, both salt and fresh, does not influence the MINEX's detection capabilities. Different soil types can be "learned" on site with a simple push button. This ensures that the detector is adapted to the specific soil without the need to choose and use preset soil types.

Power supply

The MINEX 2FD 4.500 is powered by three 1.5V D-cells. Rechargeable batteries can be used; indicated operating times vary depending on their quality and age. But detector sensitivity and detection quality are never influenced by the condition of the batteries.

Battery consumption depends on a couple of factors. At 20°C, the detector can be operated continuously for some 30 hours. At normal operating rhythm (two four-hour sessions per day) total operating time is around 50 hours. Under most circumstances, a single set of batteries ensures sufficient supply for a working week.

Detectors in use to date

- In service since early 2000, the MINEX 2FD 4.500 is mainly in use in the following countries: Afghanistan, Australia, Austria, Croatia, Denmark, Egypt, France, Guinea-Bissau, India, Mozambique, Oman, Portugal, Spain, Switzerland, Tunisia, the US, and Viet Nam;
- The previous version MINEX 2FD 4.400 with identical technological features has been in field use since 1991.

2FD 4.500 search head

Factory support

Spare parts are available exclusively from Foerster. The rechargeable batteries used for the MINEX can be purchased on the open market.

Besides the direct support from Foerster, Germany, the company provides a worldwide network of representatives in more than 40 countries, most of which offer comprehensive after-sales service. Besides offering on-site training, Foerster provides test and training areas at their facilities in Reutlingen in Germany. The areas are equipped to offer training conditions for UXO as well as mine search under a variety of scenarios. A full training programme including lessons on background knowledge and a variety of training material is available in English and German. On request, training forms part of a purchasing package. Standard manuals and service documentation are available in English, French, German and Spanish; other languages can be provided on request.

Foerster addressed different soil scenarios by offering a modification of the electronics for the exclusive search in a particular area over longer periods. Programmes for soil compensation are currently in preparation.

MINEX 2FD 4.500 in transport case

Maintenance and support

The MINEX maintenance system is organised on two levels: level one covering basic field maintenance, and level two covering workshop maintenance.

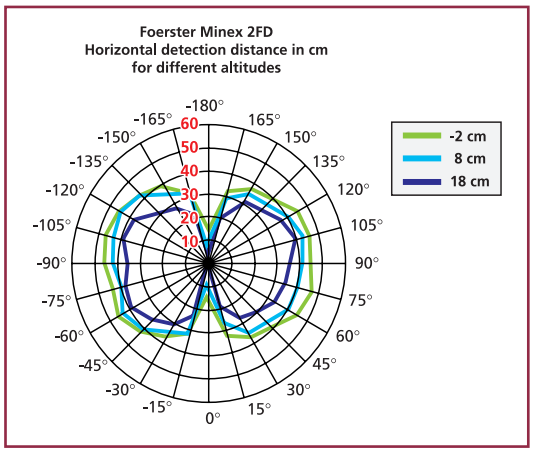
Workshop personnel must have a basic knowledge of mechanics and electronic repairs, such as experience with soldering. Foerster can supply complete toolsets and testing equipment as well as service training. Fully-equipped

workshops with trained personnel are able to handle all repairs down to the level of the factory's own final assembly.

Test and evaluation

Foerster performs tests within its own facilities, mainly for research and quality control. For the most part, the tests are performed as far as possible under "real" conditions. This includes the targets (mines and UXO) as well as the circumstances (soil, disturbing influences, etc.). The results, which form an important part of the current research, are not available publicly. Nevertheless, the Foerster training site offers the possibility for interested customers to see the equipment working under these conditions.

The MINEX 2FD 4.500 formed part of various independent tests — the results are partly available from open sources as well as directly from Foerster. For example: Test UNDP (UN Accelerated Demining Programme), Mozambique, 2000; Test International Pilot Project for Technology Cooperation (IPPTC), 2000/2001; United Nations, Afghanistan, 1999/2000; Gruppe Rüstung (Swiss Army), 2001. As a result of these tests, the detector was recommended by the Swiss Army for humanitarian demining. The detector has recently been tested by JRC in Laos but no detailed information is yet available. However, it will be soon published on the JRC website



Horizontal detection distance of MINEX 2 FD 4.500 (see JRC test, March 2001).

Known limitations and strengths:

Limitations

- **The test reports available do not point to major limitations.**

Strengths

- **Dual tone assists target pinpointing.[1]**
- **Good harness.[1]**
- **Good transit and field case.[1]**
- **One-piece design.**

1. These test results are derived from the International Pilot Project for Technology Cooperation (IPPTC) test where the previous model MINEX 2 FD 4.400 was tested (March 1999-June 2000, Annex A, p. 72). The design has changed but the technical specifications are identical.

Geophex GEM-3

Geophex, US

The GEM-3 broadband metal detector used with a palmtop on shaft

General description

Geophex introduced the **GEM-3** Landmine Detector and Identifier in 1997 as a broadband electromagnetic metal detector and discriminator for, primarily, buried UXO. The GEM-3 has been commercially available since 2001. Comprehensive technical information about the detector, including photos, journal articles and data examples, can be found on the Geophex website (*www.geophex.com*).

The GEM-3 was originally a product of a research project sponsored by the US government. It was initially developed for detecting and discriminating UXO in military ranges. Its application to landmines is new and still evolving.

Working methodology

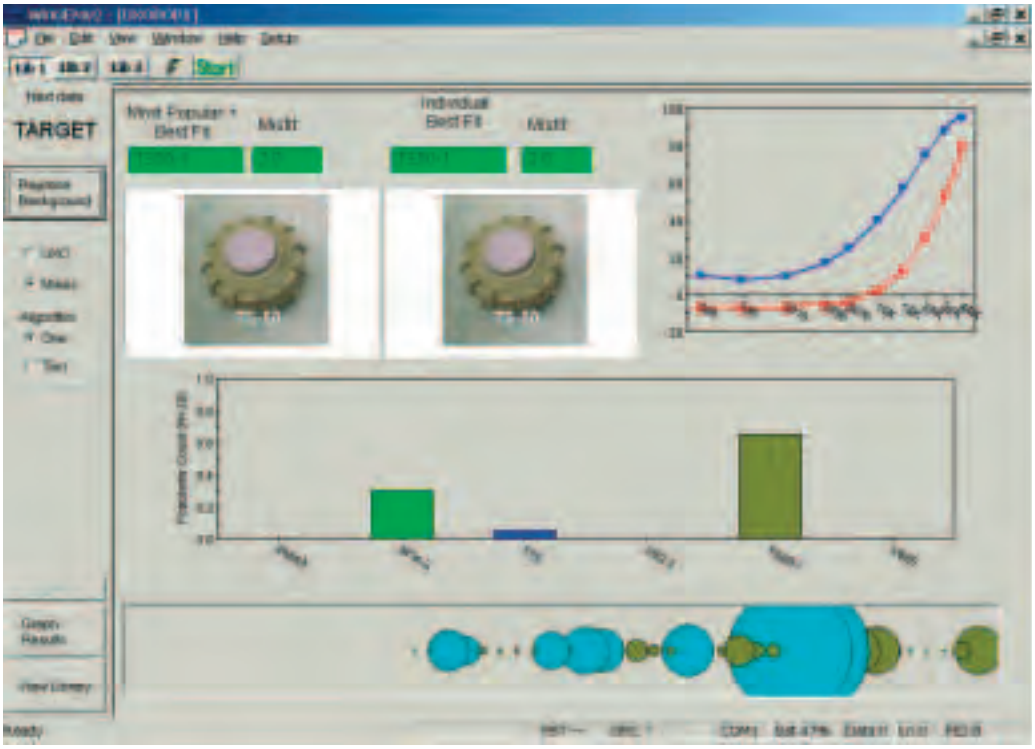
The GEM-3 sensor contains a pair of concentric transmitter coils and a small receiver coil at the center. All coils are molded into a single, light, circular disk in a fixed geometry, rendering a very portable package. The sensor head is scalable to almost any size. Attached to the other end of the boom is a removable electronic console. The sensor design is based on US Patent No. 5.557.206 entitled *Apparatus and Method for Creating a Magnetic Cavity*, dated 1996 and owned by Geophex.

The GEM-3 uses multiple frequencies (typically 10) spanning from about 300Hz to 50kHz for detection and discrimination. Local geologic conditions and mine types may affect the frequency selection. Prior to use, the GEM-3 prompts for a set of desired transmitter frequencies — the operator may choose from default options. Built-in software converts these frequencies into a digital "bit-stream", which is used to construct the desired transmitter waveform for a particular survey. This bit-stream controls a set of digital switches connected across the transmitter coil and generates a complex waveform that contains all the frequencies specified by the operator.

The GEM-3 measures two quantities at each frequency, called inphase (I) and quadrature (Q) components. For a ten-frequency operation, for instance, the sensor produces ten I- and ten Q-components at each location. The sampling rate is 30 times per second, or 30Hz.

To facilitate the detection process, the GEM-3 generates a variable-pitch, variable-amplitude audio from an internal computer using the digital data collected by the sensor. The data stream used for the audio may depend on local geology; for instance over magnetic soil, the audio is based on a digital sum of quadrature responses of all frequencies. For detecting landmines buried in laterite (magnetic) and/or conducive soils several recipes have been developed.

Once a target is detected, the GEM-3 may be used in a classification mode based on a new technology known as Electromagnetic Induction Spectroscopy, or EMIS (US Patent No. 5,963,035 by Geophex, 1999). By measuring the broadband spectral response of an object, the sensor obtains a distinct spectral signature that enables the detector to identify a landmine. Based on the response spectrum, the detector can "fingerprint" the object; this is the basic concept of EMIS. The figure below shows real-time landmine identification software being run on Windows on a typical laptop computer screen. Similar realtime software is available on a palmtop.



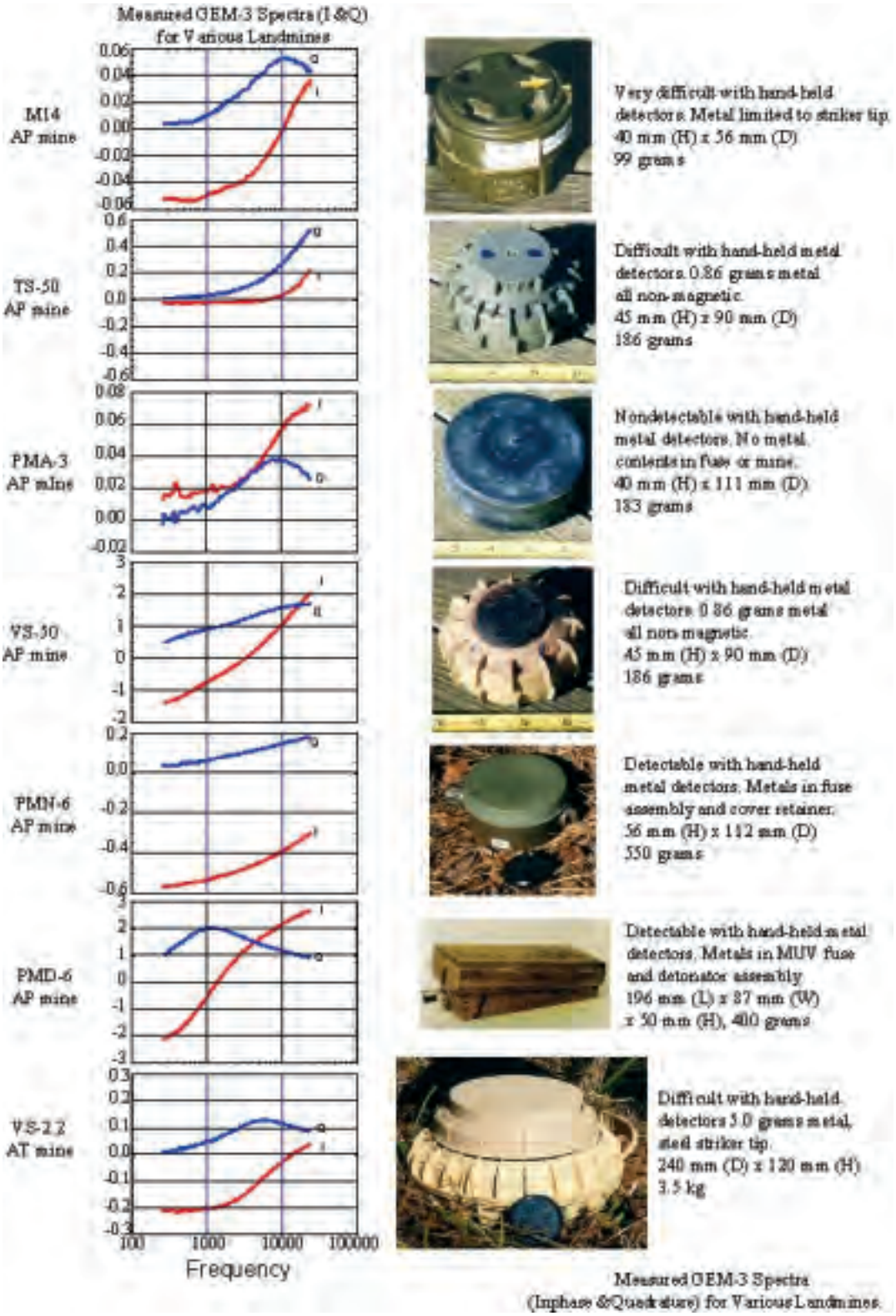
An example of the real-time screen image of the Windows interface as it appears on a laptop screen. A similar display is available for a palmtop that runs on Windows CE. The upper right graph shows the current target spectrum of in-phase (red) and quadrature (blue) at ten frequencies. The sensor compares this observed spectrum with those stored in the library that contains, for each mine, the GEM-3 spectrum and a photograph as a JPG file. This example employs three different matching codes: (1) Most Popular Best-fit (upper left), (2) Individual Best-fit (upper middle) and (3) Popularity Count as a bar graph in the middle. In this particular example, all three codes correctly picked TS-50 as the target. Percent misfit in matching is indicated for the first two codes. The circles in the bottom panel shows the "goodness of the fit" in time as the sensor moves in and out of a mine target.

Power supply

The GEM-3 has an internal rechargeable battery that can be charged from a common 12V DC outlet in cars or household 110-220V AC sources. The internal battery, powering the entire sensor, lasts about 8 hours in typical continuous operation.

Detectors in use to date

The GEM-3 is a relatively new sensor in the field of landmine detection and classification. About 50 units have been sold since early 2001 when the sensor became first commercially available. These units are more or less equally divided among the US government, universities, and EOD companies. The US government users have included: the Naval EOD Technical Division in Indian Head, Maryland; the Corps of Engineers in Huntsville (Alabama) and Fort Ord (California); Fort Belvoir Countermine Division in Virginia; the Army Engineering R&D Center of Vicksburg



Measured GEM-3 spectra, inphase (red) and quadrature (blue) for seven common landmines. The vertical scale indicates the GEM-3 response in parts per million (ppm) and relative amplitude, which is proportional to the target metal content. Such EMIS data can be used to identify particular mines by name.[1]

1. According to the manufacturer.

(Mississippi); and the Cold Region Research Laboratory in New Hampshire. The sensor has been used extensively for detecting UXO for environmental clean-up projects at military ranges.

Factory support

No further information is provided by the manufacturer.

Maintenance and support

Despite its internal sophistication, the GEM-3 is built for easy operation and maintenance. Three push buttons control the entire sensor operation based on menu displayed on a small LCD screen that provides continuous prompts to the operator.

One of the major goals for the GEM-3 is to shift the burden of mine detection and discrimination, to the greatest extent possible, from the operator to the sensor itself. The manufacturer has sought to simplify the process of audio detection and automatic target classification by internalising the decision-making process to the sensor and its computer. Therefore, the sensor has been designed, and is continuously upgraded, to minimise the training requirement for the operators.

Both the operator's manual and the sensor software may be downloaded from the Geophex website.

Test and evaluation

Extensive GEM-3 data can be obtained at the US Government test mine lanes (from Aberdeen Proving Ground in Maryland and Fort A.P. Hill in Virginia) at the JUXOCO website *www.uxocoe.brtrc.com*.

Reported limitations and strengths

No information available at this time.

Guartel MD8+

Guartel Technologies Ltd, UK

The standard MD8+ probe

MD8+ with optional short halo

General description

The **Guartel MD8+** is a hand-held metal detector suitable for use by both civilian and military personnel in all regions suffering contamination from landmines and other explosive remnants of war. The system is a high-sensitivity metal detector based on very high speed pulse induction technology; it is designed to detect minimum-metal-content mines even under difficult soil conditions. The MD8+ has a proven performance in international humanitarian and military demining and EOD operations.

All elements, with the exception of an optional external clamshell earpiece, have been integrated into a single unit incorporating a control unit, batteries and telescopic halo assembly. There are no separate parts and therefore no cumbersone interconnecting cables. The equipment is weatherproof and totally sealed. It is controlled by a microprocessor to enable precise timing, rapid switching and sophisticated signal processing.

In addition to automatic self-diagnostic procedures, the Guartel MD8+ incorporates user-initiated test procedures. The verification of these tests is indicated to the operator by a confidence tone. The MD8+ replaces the MD8, which has been in service for ten years with the military, NGOs and commercial companies worldwide.

Working methodology

The MD8+ uses high-speed pulse induction to provide optimum sensitivity capable of detecting all currently deployed minimum-metal anti-personnel and anti-vehicle mines. Automatic in both calibration and detection it is self-adjusting to the operating environment, and due to its simplicity of use only minimal training is required. All components are integrated into a single unit avoiding the need for external power packs and cables. The design and manufacture provide a rugged, sealed, water-resistant and highly-reliable detector capable of being operated in all climatic conditions. The novel detector head design and the LED array located on the turret aims to facilitate the pinpointing of target munitions under the most difficult of conditions, including the location of small targets in close proximity to large ones.

Detectors in use to date

The MD8+ is in use with the South African Defence Force, US Special Forces, demining NGOs and commercial operators in Africa, Asia, Europe and the Middle East.

Power supply

The MD8+ is powered by 3 LR20 D cells giving 18 hours of continuous use at maximum sensitivity. The power supply maintains a constant voltage to the electronics, permitting maximum performance, whatever the state of the batteries, and uses the full capacity of the cells.

Factory support

Guartel Technologies Ltd offers full factory support for its products, including spares, back-to-base repairs, and online technical support. Techncian and operator training can be provided either in the UK or in theatre.

Maintenance and support

The MD8+ is modular in construction and designed to require minimal operator maintenance apart from external cleaning and battery changing. Second-line support is only required to replace modular components, third-line support is either back-to-base repair or repair by Guartel trained technicians in-country.

Test and evaluation

Guartel Technologies Ltd tests its detectors in accordance with current standards using ITEP (International Test and Evaluation Programme), DRES (Defence Research Establishment Suffield) and other guidelines.

Due to a lack of independent test reports no additional information is available to date.

MD8+ in action, standing position

Reported limitations and strengths

Strengths

- One-piece design.

Limitations

- Reduced capability in laterite soil. This will be rectified with the manufacture of the next generation of detectors (MD10), which will have full soil-rejection capabilities and will be programmable via a modem/cable.

Minelab F1A4

Minelab Electronics Pty Ltd., Australia

Fully set-up mode of the F1A4

General description

The **Minelab F1A4** mine detector was launched on the demining market in 1997 and is now used in more than 40 countries worldwide. It began with an invitation to attend trials being conducted by the Cambodian Mine Action Centre (CMAC), which was looking for its next generation detector. In comparing the F1A4 to other manufacturers' equipment, CMAC reported that the F1A4 has a larger detection pattern, a deeper detection capability, particularly in mineralised soil conditions, and is more effective in the wet. It was also noted that the F1A4 has superior ground-balance capability, enabling it to detect all types of metal and minimum-metal mines in all soil conditions. The design enhances operator safety while remaining simple to use.

Since this initial success Minelab has maintained the F1A4's competitive edge with mechanical and technical improvements.

The detector has proved its effectiveness in Afghanistan, Cambodia, Iraq, Lebanon, and Mozambique, and has demonstrated far-above-average performance in finding low-metal-content mines.[1] The F1 family includes detectors designed for minimum-metal mines, anti-vehicle mines, UXO, and an enhanced deep target detector with data logging and mapping capability.

Working methodology

The F1A4 uses a technology system called multi-period sensing to reduce background interference caused by heavily-mineralised soils. The background noise caused by soil often masks a detector's ability to detect accurately the small metal firing pin used in minimum-metal landmines that have been laid around the world. The F1A4 transmits pulses of electromagnetic energy into the ground below its coil. These pulses of magnetic energy cause metal objects in the ground, through induction, to produce a changing magnetic field of their own. The F1A4 receives the signals from the metal targets between its transmitted pulses and is able to negate the interference caused by mineralised soils while still responding to metal targets. This is achieved by transmitting a continuous train of alternating long and short magnetic field pulses. The decay relationships from signals received from metal and iron oxide are known. In the absence of metal, iron oxide will return a predicted signal that the detector can identify. If metal exists in the soil, the return signals result in a different relationship that alerts the operator to the presence of metal. Target indication is provided by a constant threshold tone which excites and increases in volume when a target is found.

Power supply

The F1A4's power system:

- operates with commercially-available alkaline and rechargeable batteries;
- operates for at least five days in normal operation before requiring battery change;
- makes maximum use of simplified start-up and "test and adjustment" procedures;
- has been designed to meet both military and civilian demining requirements and incorporates safety features such as "low battery" warning, and an audible "OK" signal at the end of the setting cycle.

Detectors in use to date

Minelab first supplied the F1A4 (Version 1) mine detector to CMAC in 1997 having been selected as the detector of choice following international trials conducted in Cambodia. CMAC continued to purchase the F1A4 until 2003. During that period the F1A4 Version 1 underwent modification in response to field experience, customer requirements, and improved manufacturing processes. CMAC's inventory currently numbers in excess of 1,300 detectors and includes the latest version of the F1A4 (Version 8). Following the CMAC trial, the F1A4 was evaluated by the UN Mine Action Centre in Bosnia and Herzegovina and was accepted for use there.

Following these initial successes, the F1A4 has been involved in several trials and evaluations worldwide and is now used by several armed forces, the United Nations, the US Department of State, NGOs, and commercial demining companies. Over the past three years, Minelab F1A4 detectors have been supplied to more than 200 customers in 50 countries. In 2002, the Australian Army and Canadian Forces decided to supplement their existing F1A4 detector fleet with a further significant purchase. The US Army also purchased the F1A4 complete with an integrated logistic support package.

Factory support

Minelab provides its Customer Service and Technical Support Team to carry out "Train the Trainer" sessions at a designated site. Training includes comprehensive theory coupled with component identification, set-up, operation and maintenance. Based on a class size of up to 16 participants and the ease of operation of the unit, the F1A4 training course should not take more than three days.

Comprehensive training and instruction is also provided for technicians to enable basic fault-finding and component replacement, and includes guidance on coordinating the Minelab repair system and arranging for medium-level repairs. Training and all documentation are provided in English, or if requested, another language.

Support and spares are provided from Minelab's two manufacturing facilities in Australia and Ireland and from other authorised repair facilities regionally. The F1A4 is covered against material or manufacturing defects by a one-year warranty.

Maintenance and support

The F1A4 is a very simple detector to operate and repair and has a low requirement for spare parts, tools, equipment and maintenance. Technician training is minimal. Five minutes each day is all that is required by the operator to maintain the F1A4 and it has no lifetime-programmed repair or maintenance. A very limited workshop facility is all that is required to support the F1A4 in the field.

The F1A4 can effectively compensate for mineralised soils

Test and evaluation

The following test and evaluation trials have concluded that the Minelab F1A4 is acceptable for humanitarian demining in all soil types:

- UNMAC, Bosnia and Herzegovina, 1997;
- Armour Group Kosovo, 1999;
- UNOCHA trial, Afghanistan, 2000;
- Accelerated Demining Programme Mozambique, 2000;
- International Pilot Project for Technology Cooperation (IPPTC), 2001;
- UNOPS, Afghanistan, 2002;
- Gruppe Rüstung (Swiss Army), 2001;
- JUXOCO's trial in 2002;
- Canadian Forces trial 2002;
- The detector has recently been tested by JRC in Laos but no detailed information is yet available. However, it will be soon published on the JRC website.

Reported limitations and strengths[1]

Limitations:

- **Poor for pinpointing multiple targets.**
- **Weak screws securing the control box and head.**

Strengths:

- **Choice of earpiece (allows use of speaker at the same time).**
- **Ease of set-up and operating procedure.**
- **Versatility of control box location.**

1. Y. Das, J.T. Dean, D. Lewis, J.H.J. Roosenboom, G. Zahaczewsky (eds), *A multi-national technical evaluation of performances of commercial off the shelf metal detectors in the context of humanitarian demining*, International Pilot Project for Technology Co-operation, Final report, European Commission, Joint Research Centre, Ispra, Italy, 2001, p. 92.

Minelab F3

Minelab Electronics Pty Ltd., Australia

Compact Minelab F3

Transport case

General description

The **Minelab F3** was designed from its inception in consultation with many of Minelab's demining clients. Released in July 2003, the F3 is an extremely compact, full-size detector providing automatic ground balancing and rugged mechanical design. While the detector shares many features with the well-established Minelab F1A4 Mine Detector (for example, its ability to "ground balance" to remove the response of ground mineralisation with negligible loss of target sensitivity), it also has a number of new features. Bipolar technology is employed to minimise the risk of the detector detonating magnetic influence mines, and direct coupling allows the detector to emit a tone when a metallic target is present, even if the detector search head is at rest.

Initially the F3 will be offered configured for demining operations but in time it will be provided with interchangeable coils allowing the deminer to alternate between mines and UXO without retuning the detector — this will be done automatically. The F3 does not require set-up or assembly, it has only to be extended via the telescopic shafts to the desired length and switched on. The F3 has only three simple buttons making it extremely easy for the operator to identify and operate. It is waterproof down to two metres allowing it to be operated in all climatic conditions.

The F3 and its bipolar technology will be the basis for a family of detectors to be released over the next few years, including an UXO and miniature model for smaller applications.

Working methodology

The F3 metal detector is designed to detect a wide variety of mines and ordnance in even the most difficult ground conditions. It operates on the "pulsed induction" principle, using a mono-loop transmit/receive coil. The F3 has "selectable sensitivity", which can be directed by the demining section commander or site supervisor to the deminers in the field. The F3 comes with a number of rubber end caps, each with their own in-built level of sensitivity and coloured markings for identification. For example, a supervisor can order the black end cap to be exchanged with a red one, which automatically changes the sensitivity of the detector. Results from Laos show that in this mode, the F3 largely ignores surface shrapnel but still finds metal mines, such as the PMN-2, or BLU cluster bomblets at depth. Of course, if the threat is minimum-metal mines, such as the M14 or Type 72 B, it would be wise to select maximum sensitivity.

Minelab has designed the change of sensitivity this way to maintain their philosophy on safety. Many detectors have a sensitivity switch. This is considered to be unsafe, because an operator can accidentally select a lower sensitivity and the supervisor will never know. With the F3 the supervisor always knows the sensitivity of each of the detectors by looking at the colour of the end caps.

Minelab F3 in operation

Power supply

The F3's power system:

- operates with commercially available alkaline and rechargeable batteries;
- operates for at least five days in normal operation before requiring battery change;
- makes maximum use of simplified start-up and "test and adjustment" procedures;
- has been designed to meet both military and civilian demining requirements and incorporates safety features such as a "low battery" audible warning.

Detectors in use to date

Since the F3's release to the market in July 2003 there has been heavy demand for its delivery to past and new clients, including RONCO (for Iraq), the Sri Lankan armed forces and the US Marines.

Factory support

Minelab provides its Customer Service and Technical Support Team to carry out "Train the Trainer" sessions at a designated site. Training includes comprehensive theory coupled with component identification, set-up, operation and maintenance. Based on a class size of up to 16 participants and the ease of operation of the unit, the F3 training course should not take more than three days.

Comprehensive training and instruction is also provided for technicians, to enable basic fault-finding and component replacement, and guidance on coordinating the Minelab repair system and arranging for medium-level repairs. Training and all documentation are provided in English, or if requested, another language. Support and spares are provided from two manufacturing facilities in Australia and Ireland and from other authorised repair facilities regionally. The F3 is covered against material or manufacturing defects with a one-year warranty.

Maintenance and support

The F3, like its cousin the F1A4, is a very simple detector to operate and repair and has a low requirement for spare parts, tools, equipment and maintenance. Technician training is minimal. Five minutes each day is all that is required by the operator to maintain the F1A4 and it has no lifetime programmed repair or maintenance. Only a very limited workshop facility is needed to support the F3 in the field.

Test and evaluation

A number of trials and evaluations have taken place. The trials have been conducted for both mine and UXO detection. Test reports from the following organisations are available through the manufacturer:

- Joint Unexploded Ordnance Coordination Office (JUXOCO) (US Army - 2002);
- Mines Advisory Group (MAG — Laos 2002);
- Joint Research Centre (ISPRA — November 2002);
- The detector has recently been tested by JRC in Laos but no detailed information is yet available. However, it will be soon published on the JRC website.

Reported limitations and strengths

No information on limitations and strengths from independent, comparative tests is currently available.

Schiebel AN-19/2

Schiebel Elektronische Geräte GmbH, Austria

Schiebel AN-19/2 with carrying bag

General description

The **AN-19/2 Mine Detecting Set** is one of the most widely-used and easily-recognisable mine detectors in the world. It is built to military standards to meet the requirements for mine clearance on the battlefield and is now also used for humanitarian demining. It has been in daily use for the last 11 years in the world's most mine-affected countries and is the standard detector for many NATO countries, including the US Army[1] (designated AN/PSS-12).

Because of its ease of use, low power requirement, lightweight design and the low mutual interference, the AN-19/2 is mission-suitable for all kind of demining activities. The equipment is able to detect mines with minimum metallic content and can be used in shallow fresh or salt water. Unaffected by ambient temperature, the excellent detection characteristics of the AN-19/2 qualify the equipment for use in all climates. The AN-19/2 is a reliable, long-life product based on rigorous standards of quality control during manufacture. Although there have been several modifications to the original AN-19/2 pulse detector throughout its life, culminating in the current Mod. 7, the method of operation has remained the same for all variations.

Since many Schiebel detectors have been in operation for more than ten years, the company offers a kit that upgrades the older detectors to the latest technology in landmine detection equipment. This upgrade allows the user to retain the trusted and proven design of the AN-19/2 while increasing sensitivity and allowing operation of the detector in mineralised soils such as laterite and magnetite.

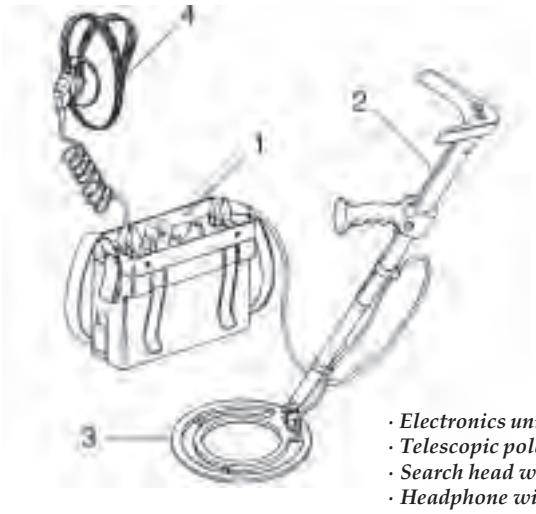
The upgrade consists of a new search head and a new electronics card which, once installed, allow the detector to act either as an AN-19/2 or an ATMID™ depending on which search head is used. In the pulse, or AN-19/2 mode, the detector operates the same way as the original detector, yet with increased capacity in normal soils. In the Continuous Wave, or All Terrain Mine Detector (ATMID™) mode, the detector uses new technology and a new search head to detect minimum-metal-content mines in even the most difficult mineralised soils. The upgrade combines both technologies into one detector to provide ultimate versatility in varied operating conditions.

Working methodology

The search head emits an electromagnetic pulse, which induces eddy-currents in nearby metal objects. These eddy-currents give rise to a secondary field, which is detected by the search head receiving coil. The detected signal is processed in the electronics unit. The presence of a metal object is indicated by a tone in the headphone and by an optional LED visual signal, if fitted.

AN-19/2 detects mines at their operational depth (or deeper). Schiebel's test piece incorporates a 0.15g steel pin (approximately the same signature as the Chinese Type 72A anti-personnel mine) that can be detected at 17cm when buried in the ground[1] (only 12cm in light magnetic soil — for heavier magnetic soil, use the Schiebel ATMID™). This is maintained in fresh/salt water (down to 2m).

For large magnetic signature mines/UXO, the detector gives an over edge of target indication enabling the same precise location as for smaller targets.



- *Electronics unit with shoulder strap (1)*
- *Telescopic pole with arm support and handle (2)*
- *Search head with cable and plug (3)*
- *Headphone with cable and plug (4)*

Schematic diagram of AN-19/2

Power supply

AN-19/2 is powered by four standard D-size cells. The recommended alkaline cells provide approximately 70 hours operation. Similar rechargeable nickel-cadmium cells provide approximately 35 hours. All recommended cells are available worldwide as are suitable automatic chargers.

Rechargeable cells last for at least one year if correctly used/charged.

Detectors in use to date

According to the manufacturer more than 40,000 AN-19/2s have been sold in four versions (Modification 2, 5 and 7) since 1990. It is impossible to say how many of each are in service as many have been upgraded to later modifications. The current production is Mod. 7.

Different versions are in use in mine-affected regions all over the world, including in Afghanistan, Angola, Bosnia and Herzegovina, Croatia, Cambodia, Iraq, Kosovo, and Mozambique. They have been purchased and are still used by organisations such as the United Nations, MAG (Mines Advisory Group), CMAC (Cambodian Mine Action Centre), Handicap International, most of NATO including the US, and many other armed forces (Colombia, India, Sweden, etc.).

Factory support

- All detectors are covered by a 12-month, no-cost warranty, and operator/maintenance training is provided (on site or at the factory, as requested) as part of the procurement package. Further training can be provided at cost;
- Spare parts, all interchangeable (regardless of detector version), are available for a period of ten years after purchase. These can be obtained directly from the factory or from the worldwide network of Schiebel agents;

- Operator and maintenance manuals are provided in most major languages (e.g. English, French, German, Spanish, etc);
- Schiebel technicians/factory repairs are available worldwide to provide additional support whenever required.

Maintenance and support

The AN-19/2 requires little maintenance and can be upgraded to the latest modification state. Most repairs can be carried out, at field level, by Schiebel trained personnel. Workshop repairs can be carried out by Schiebel trained technicians, using the recommended tools and test equipment (digital multi-meter and oscilloscope).

Test and evaluation

The AN-19/2 has been comprehensively field-tested in all climates by the manufacturer and all detector specifications are fully proven. It has also been evaluated and selected by a wide range of operators, including the US Army and the British NGO, MAG. Additional test reports are available on request from the manufacturer.

The European Commission Joint Research Centre (JRC) states that the Schiebel AN-19/2 detects a VPROM 1 with a sufficient safety margin at all angles.[2]

The detector performed above average in all types of soil (sand, clay, peat, and ferruginous).[3]

The most significant tests passed by the detector are:
- International Pilot Project for Technology Cooperation, March 1999-June 2000;
- International Detector Test UNADP Mozambique, December 2000;
- US Army Communications Electronics Command – Nicaraguan Field Test, October 2001;
- European Commission Directorate General JRC – Institute for Systems, Informatics & Safety.

Test reports were partially published and are accessible.

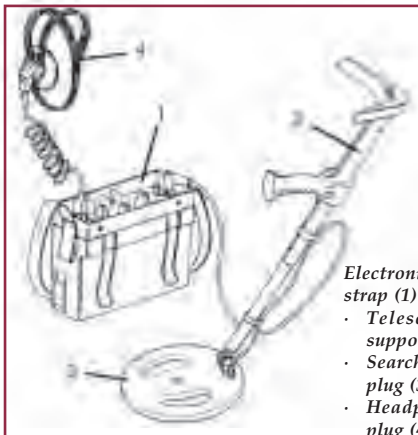
Reported limitations and strenghts[3]

Limitations:	*Strengths*
▪ **No external speaker.**	▪ **Light weight.**
▪ **Exposed cable.**	▪ **Rugged and weatherproof.**
▪ **Lack of standard bracket to mount electronics box on detector shaft.**	▪ **Easy to use.**

1. According to the manufacturer.
2. M. Fernandez, A. Lewis, F. Littmann, *PROM 1 Anti-personnel landmines - Probability of activation by physical contact with a metal detector*, Special publication No. I.01.29, European Commission Directorate General JRC Joint Research Centre Institute for Systems, Informatics & Safety, Ispra, March 2001, Annex A, p. 100.
3. Y. Das, J.T. Dean, D. Lewis, J.H.J. Roosenboom, G. Zahaczewsky (eds), *A multi-national technical evaluation of performances of commercial off the shelf metal detectors in the context of humanitarian demining*, International Pilot Project for Technology Co-operation, Final report, European Commission, Joint Research Centre, Ispra, Italy, 2001, Annex A, p. 101.

Schiebel ATMID™

Schiebel Elektronische Geräte GmbH, Austria



Electronics unit with shoulder strap (1)
- *Telescopic pole with arm support and handle (2)*
- *Search head with cable and plug (3)*
- *Headphone with cable and plug (4)*

Schematic diagram of ATMID™

Schiebel ATMID™ with carrying bag

General description

The **ATMID™** (All Terrain Mine Detector) is the latest improvement of the AN-19/2 using the continuous wave mode combined with ground-compensating technology. The ATMID™ is a military standard detector that is unaffected by climatic variations and has been optimised to detect landmines with minimum-metal content in all types of soil, including laterite terrain, and/or in fresh or salt water. The manufacturer states that its sensitivity in ferromagnetic soils remains at the same level. The mine detector, including all accessories, is packed in a carry bag fitted with straps so that it can be carried like a rucksack. The ATMID™, however, when fitted with the standard AN-19/2 search head, will function in pulse mode with the same performance as the AN-19/2 (see AN-19/2 data sheet for further details).

Because of its ease of use, low power requirement, lightweight design, environmental stability and automatic ground compensation, the ATMID™ is suitable for use anywhere in the world, in any terrain.

The ATMID™ is also available as an upgrade to the AN-19/2. The upgrade consists of a new search head and a new electronics card which, once installed, allow the detector to act either as an AN-19/2 or an ATMID™ depending on which search head is used. In the pulse, or AN-19/2 mode, the detector operates the same way as the original detector, yet with increased capacity in normal soils. In the Continuous Wave, or ATMID™ mode, the detector uses new technology and a new search head to detect minimum-metal-content mines in even the most difficult mineralised soils. The upgrade combines both technologies into one detector to provide ultimate versatility in varied operating conditions.

Working technology

The ATMID™ transmitting coil transmits a continuous wave that creates a magnetic field and which is able to compensate for magnetic soil. The sweeping movement of the search head over the ground induces eddy currents in any nearby metallic objects, which affect the created magnetic field. The receiver coil detects the resultant changes in magnetic field and produces a signal that is processed in the electronics unit to provide an audio tone indicating the presence of metal.

ATMID™ detects nearly all mines at deeper than operational depth in any/all soils. Schiebel's test piece incorporates a 0.15g steel pin (approximately the same signature as the Chinese Type 72A anti-personnel mine) that can be detected at 18cm when buried in the ground, including under surface fresh/salt water.[1]

For large-magnetic-signature mines/UXO, the ATMID™ gives an edge of target indication enabling the same precise location as for smaller targets.

Power supply

The ATMID™ is powered by four standard D-size cells. The recommended alkaline cells provide approximately 70 hours operation (in most conditions). Similar rechargeable nickel-cadmium cells provide approximately 35 hours operation. All recommended cells are available worldwide, as are suitable automatic chargers. Rechargeable cells last for at least one year if correctly used/charged.

Detectors in use to date

The ATMID™ has been in service for more than two years and there are now more than 1,000 in use worldwide. They are being deployed in many regions, including Cambodia, Croatia, Ecuador, Laos, Lebanon, Mozambique, Peru, Slovakia, Taiwan, the US, and Viet Nam. They were purchased and are still being used by armed forces from a number of countries (Cambodia, Sweden, US, etc.), humanitarian demining organisations (CMAC, CROMAC, MAG, etc.) and commercial demining companies (Specialist Ghurkha Services [SGS], RONCO, Milsearch, TADS, etc.).[1]

Factory support

- All detectors are covered by a 12-month, no-cost warranty and operator/maintenance training is provided (on site or at the factory as requested), as part of the procurement package. Further training can be provided at cost;
- Spare parts, all interchangeable, are available for a period of ten years after purchase. These can be obtained directly from the factory or from the worldwide network of Schiebel agents. Operator and maintenance manuals are provided in most major languages (e.g. English, German, Spanish, etc.);
- Schiebel technicians/factory repairs are available worldwide to provide additional support whenever required.

Maintenance and support

The ATMID™ requires little maintenance due to its high reliability. Most repairs can be carried out in the field by Schiebel-trained personnel. Limited workshop repairs can be carried out by Schiebel-trained technicians, using the recommended tools and test equipment (digital multi-meter and oscilloscope).

Test and evaluation

The manufacturer states that it has comprehensively field-tested the ATMID™ in all climates and that all detector specifications are fully proven. It has also been evaluated by several organisations, including the British NGO MAG, CMAC, and others. Additional test reports are available on request from the manufacturer.

Tests passed by the detector include:

- UNOPS test for the UN Mine Action Programme in Afghanistan, February-March 2002;
- International Pilot Project for Technology Cooperation, March 1999-June 2000;
- International Detector Test, UNADP Mozambique, December 2000.

Test reports were partially published and are accessible. The detector has recently been tested by JRC in Laos but no detailed information is yet available. However, it will be soon published on the JRC website

Reported limitations and strengths[2]

Limitations	*Strengths*
▪ No external speaker.	▪ Lightweight and easy to use.
▪ Exposed cable.	▪ Rugged and weatherproof.
▪ Lack of documentation for search head use.	▪ Versatile.

1. According to the manufacturer.
2. Y. Das, J.T. Dean, D. Lewis, J.H.J. Roosenboom, G. Zahaczewsky (eds), *A multi-national technical evaluation of performances of commercial off the shelf metal detectors in the context of humanitarian demining*, International Pilot Project for Technology Co-operation, Final report, European Commission, Joint Research Centre, Ispra, Italy, 2001, Annex A, p. 102.

Schiebel MIMID™

Schiebel Elektronische Geräte GmbH, Austria

Foldable Schiebel MIMID™

General description

The **MIMID™** (Miniature Mine Detector) is based on the pulse mode technology of the AN-19/2 mine detector that has been the worldwide standard for minimal-metal-mine detection in both military and humanitarian demining for the past ten years. It was developed to meet the specific operational requirements of the US Army Humanitarian Demining Team. It is waterproof to 30m and is suitable for use both on land and by divers for underwater operations. The detector has been in service since 1997.

The lightweight, one-piece, foldable design makes it suitable for use by Special Forces and anyone else likely to come into contact with mines. The folded unit can be carried on a belt, in a trouser pocket, or in a rucksack. This unique feature allows operators immediate access to the unit when needed.

The MIMID™ can be set up for operation in 30 seconds. Controls are within easy reach of the operator and are identical to those of the AN-19/2. The length of its telescopic pole can be quickly adjusted for operation in the upright, kneeling or prone positions.

Working methodology

The transmitting coil of the search head emits an electromagnetic pulse, which induces an eddy current in metal objects in the vicinity of the search head. These eddy currents give rise to a secondary field, which is picked up by the receiving coil. The signal from this coil is processed in the electronics unit. The operator is alerted to the presence of a metal object by a sound in the headphone and a light signal on the visual indicator.

Schiebel's test piece incorporates a 0.15g steel pin (approximately the same signature as the Chinese Type 72A anti-personnel mine) that can be detected at a depth of 13cm when buried in the ground. This performance is maintained in underwater depths of some 30m.[1]

For large-magnetic-signature mines/UXO, the detector gives an over edge of target indication enabling the same precise location as for smaller targets.

Power supply

The MIMID™ is powered by four standard AA-size cells. The recommended alkaline cells provide around 7 hours[1] operation. Similar rechargeable nickel-cadmium cells provide approximately 4 hours. All recommended cells are available worldwide as are suitable automatic chargers.

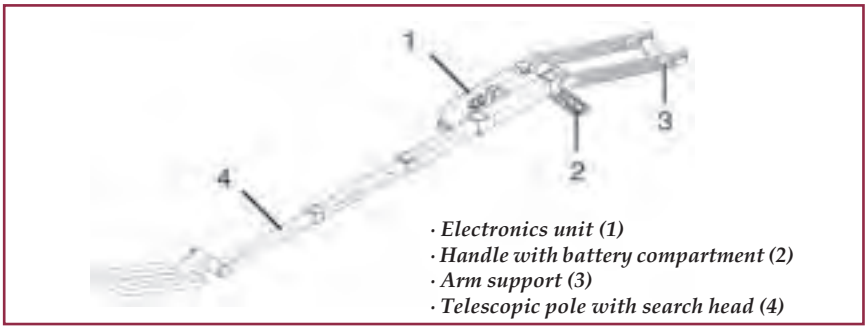
Rechargeable cells last for at least one year if correctly used/charged.

Detectors in use to date

More than 1,500 MIMID™ detectors have been sold since 1997. They have been purchased and are still used by a number of armed forces, for example Israel and the US.

Factory support

- All detectors are covered by a 12-month, no-cost warranty, and operator/maintenance training is provided, (on site or at the factory as requested), as part of the procurement package. Further training can be provided at cost;
- Spare parts, all interchangeable, are available for a period of ten years after purchase. These can be obtained directly from the factory or from the worldwide network of Schiebel agents;
- Operator and maintenance manuals are provided in English, German, and Spanish. Schiebel technicians/factory repairs are available worldwide to provide additional support upon request.



Schematic diagram of MIMID™

Maintenance and support

The MIMID™ requires little maintenance due to its high reliability. Most repairs can be carried out at a workshop by Schiebel-trained technicians, using the recommended tools and test equipment (digital multi-meter and oscilloscope).

Test and evaluation

The MIMID™ has been comprehensively field-tested in all climates by the manufacturer, including underwater trials to 30m, and all detector specifications are fully proven. It has also been evaluated by Ecuador and the US Test reports are available on request from the manufacturer. The detector scored well in all kind of soil types. The results achieved in ferruginous soil were above average.[1]

Tests passed by the detector include:

- International Pilot Project for Technology Cooperation, March 1999-June 2000;
- Gruppe Rüstung (Switzerland): *Technische Erprobung von Minensuchgeräten*, August 2001.

Test reports were partially published and are open to the public.

Reported limitations and strengths[2]

Limitations:

- **No transit case.**
- **Handle does not lock down.**
- **Elbow restraints and shaft latches are weak.**

Strengths:

- **Lightweight and compact.**
- **Weatherproof.**
- **Pre-assembled.**

1.According to the manufacturer.

2. Y. Das, J.T. Dean, D. Lewis, J.H.J. Roosenboom, G. Zahaczewsky (eds), *A multi-national technical evaluation of performances of commercial off the shelf metal detectors in the context of humanitarian demining*, International Pilot Project for Technology Co-operation, Final report, European Commission, Joint Research Centre, Ispra, Italy, 2001, Annex A, p. 104.

Stolar EDIT-3

Stolar Research Corporation, US

EDIT-3 landmine detector (Electromagnetic wave Detection and Imaging Transceiver)

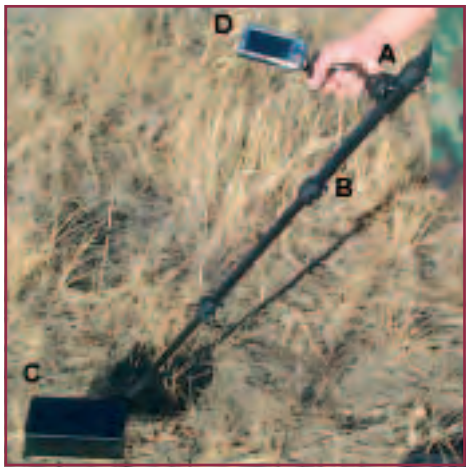
General description

The Electromagnetic wave Detection and Imaging Transceiver (EDIT) landmine detector is based upon a proven technology that was originally developed for the coal mining industry. Mining machine automation requires that the cutting edges do not cut beyond the coal seam (into the boundary rock layers). It was discovered that a Resonant Microstrip Patch Antenna (RMPA), when faced toward the boundary rock, exhibited driving point impedance that varied with uncut coal thickness; thus, microcomputer-controlled impedance measurements could be related to thickness. Subsequent science and engineering investigations demonstrated that the RMPA sensor impedance also significantly changed when scanned over shallow-buried non-metallic and metallic anti-personnel and anti-vehicle landmines.

The EDIT landmine detector is unique in that the RMPA impedance is immediately mapped on the color LCD graphics display as the sensor is swept over the soil. To create an imaging display, the x-y-z positions for the sensor head are determined in real time by internal accelerometers and gyros. The EDIT landmine detector has been developed by Stolar Research Corporation for the US Army as a Close-In Man-Portable Mine Detector (CIMMD).

The EDIT landmine detection system is comprised of the hand grip, the telescoping shaft, the sensor head, the personal digital assistant (PDA), and the battery pack.

The basic hand-held system is comprised of the hand grip (A), the telescoping shaft (B), the sensor head (C), and the PDA (D). The head-positioning system is internal to the sensor head and the battery pack is worn by a belt or shoulder strap. The battery cable plugs into the upper end of the telescoping shaft. The total length of the hand-held unit when collapsed is 18 inches. The maximum length of the unit with the shaft fully extended is 56 inches. The weight of the basic hand-held unit is four pounds. The battery pack can be worn on either a belt or shoulder strap and weights two pounds.



EDIT-3 landmine detection system components: the hand grip (A), the telescoping shaft (B), the sensor head (C), and the PDA (D)

The EDIT detector when fully deployed is gripped in one hand while the second hand can operate the function and menu keys on the PDA display. The battery pack cable plugs into a connector at the upper end of the shaft. The battery is 15 VDC and is rechargable using an AC wall adapter. The power cable going down the shaft is internally housed and the telescoping action of the four-piece shaft does not affect the system. The position of the sensor head is fully adjustable using the thumb screw at the head joint. The PDA display also rotates through 90 degrees from parallel to the shaft to perpendicular to the shaft.

The PDA Display is a Hewlett Packard iPAQ h2215. The PDA has a five-button key pad for operating the menus of the display, as well as touch screen capabilities. A thumb button is located in the middle of the PDA for measurement triggering and mapping. The PDA mounts within an adjustable bezel on the handle of the shaft just above the padded grip. Screen contrast and volume are adjustable and headphones are optional. The PDA communicates with the sensor head via a wireless Bluetooth-encrypted radio link, and data is stored on the PDA within Secure Media memory cards (up to 512 MB). The PDA can also be linked to a remote laptop up to 300 feet away using wireless LAN accessories.

EDIT-3 landmine detector PDA display head

The goal of the development was to create an affordable and sustainable instrument designed to collapse and fold up on itself for easy transport with a minimum of steps, and one that does not require external connector attachments. The design also incorporates a more ambidextrous versatility that allows an out-of-the-box operating capability with no in-field modification of the assembled instrument. Besides the ergonomic design features, the instrument produces silhouette images to assist in identification of the buried source object. The current status of the EDIT program has passed beyond technology demonstration and has moved into development of a production unit available since the summer of 2004.

Working methodology

The **EDIT-3** (Electromagnetic wave Detection and Imaging Landmine Detector) detector is swept over 1m by 1m of soil, producing a two-dimensional image of anomalies in the soil based on the contrast between the dielectric constants of the soil and landmine. Deviation from the background signal is indicated by grayscale images on the screen and by an audio tone. The sensor head can be used at heights of 1 to 6 inches above the soil surface. Sensitivity can be adjusted to optimise performance for a given target and/or soil type.

The detection range is surface to 12 inches for non-metal targets, and surface to 18 inches for metal targets.[1]

The EDIT-1 and EDIT-2 landmine detectors successfully detected anti-personnel mines buried in clay and gravel lanes during military testing. The smallest minimum-metallic landmine (M14) produced a response signal that was a factor of 6.6 times greater than the background geologic noise. Metallic landmines produce 30 per cent greater response. EDIT-3 shows increased sensitivity to the two previous models. The signal-to-geologic noise (S/N) ratio is one of the key factors in determining the probability of detection. Another key factor is the imaging capability of the EDIT-3 detector that enables the classification as well as the discrimination against clutter.

The unprocessed S/N of the EDIT-3 landmine detector is significantly greater than other competitive technologies, such as the nuclear quadripole resonance type of sensors. The implications of high S/N ratios are exceedingly important. First, computational complex algorithms are not needed in the detection and imaging process as they are for the low S/N ratio detection method. Secondly, the power demand of the instrument is low so that a compact and low-cost unit can be provided for

deminers and war fighters. However, it must have additional protection and robustness before it can be fielded for the rigours of military use.

According to the manufacturer EDIT-3 can detect metal, low-metal, and non-metal anti-personnel and anti-vehicle mines as well as UXO. EDIT has a minimal response to clutter. Clutter noise is composed of both geologic and man-made objects that cause a detector output signal. Geologic objects that produce clutter noise would include rough soil surfaces, buried rocks, and roots. Man-made objects that produce clutter noise would include shrapnel, shell casings, and other objects.

Mines are indicated by color silhouette images on the PDA screen, and by an audio tone indicator. To confirm the areas of the soil that have been scanned and help to achieve 100 per cent probability of detection, scanning of the entire search area must be assured by electronic X-Y tracking and display of the sensor head position. When initialised, the detector display shows a cross-hatched representation of the area to be scanned. The aperture of the sensor is shown as a moving cursor on the screen and erases the crosshatch of the search area, ensuring that the entire area can be confirmed as scanned by the sensor head.

The sensor head positioning system is comprised of an inertial tracking system featuring low-noise MicroElectroMechanical Systems (MEMS) accelerometers and rotational sensors.

The EDIT detector is calibrated on site for each soil type it is used in. The calibration process, which takes less than a minute, tunes the radio frequency section for optimal performance in that soil.

Detectors in use to date

Information not available.

Power supply

Battery type is a 15-VDC sealed lithium ion cell. The battery pack cable plugs into a connector at the upper end of the shaft. The battery pack can be worn on either a belt or shoulder strap and weighs two pounds.

The battery is rechargable using an AC wall adapter. It draws 1.2A on a 15-VDC battery and the operational life of the battery is 8 hours on a standard battery pack at standard temperature and pressure.

Factory support

Information not available.

Maintenance and support

Information not available.

Test and evaluation

The EDIT detector has undergone several detection capabilities test phases sponsored and supervised by US Department of Defense officials. Details are not available. Several non-military field and laboratory (in-house) test phases have also been performed. In-house test reports are available.

Reported limitations and strengths

No information due to a lack of independent test reports.

1. According to the manufacturer.

Vallon VMC1

Vallon GmbH, Germany

Vallon VMC1 unfolded

Folded Vallon VMC1 with carrying bag

General description

The **VMC1 Mine Detector** has been designed for the highly accurate detection of all types of metallic mines as well as plastic mines with minimal metal content, bombs, ammunition, and other metallic objects located in the ground or in shallow water.

It is a one-piece design retractible detector supplied in a soft carrying bag, with carrying belt housing the complete mine detecting set and a non-magnetic prodder. Due to its small packing size it needs very little space for transportation and can easily be stored in personal luggage or in vehicles.

Ergonomic operation and indication elements integrated in handgrip ensure easy operation and minimum operator training. Metal alarm is by audio signal, visual bargraph and vibration alarm.

Operator controls are limited to an one-mode selector with two soil programmes and three push buttons for setting the sensitivity level, the volume of the audio signal, and compensation/ ground balance. Data input allows for further upgrade of the detector's firmware.

Along with its digital signal processor the VMC1 uses the function principle of an advanced pulse-field specially improved by Vallon. It can work also in strongly mineralised soils, like laterite, magnetite, magmatite as well as in shallow water (salt and fresh water) and under the electromagnetic influence of main power lines without affecting the detector's sensitivity too much.

The detector complies to environmental conditions according to MIL STD 810F, 501.4-II, 502.4-I, 502.4-II, 503.4, 506.4-III, 514.5 C1.

Main components

1. Oval search head with telescopic carrying bar. Detector electronics with integrated non-magnetic loudspeaker, power supply and battery compartment. LED bargraph with 14 elements and a vibrator. Three rigid push buttons for sensitivity control, ground compensation as well as volume control at the front panel of the housing. On/off switch for two different ground conditions.
2. Non-magnetic test piece.
3. One set (3 EA) round cells 1.5V IEC R 14 alkaline C-size, 7.8A/h each.
4. Operation manual.
5. Field manual.
6. Carrying bag for storing the complete VMC1 detector set with all accessories.

Optional accessories (available on request)

1. Headset.
2. Mini prodder.
3. Hard case for storing the complete detector set VMC1 with all accessories.

Working methodology

The search head continuously emits electromagnetic pulses as the operator sweeps close to the surface. The search head acts as both an emitter and a receiver as it now senses the time behaviour of the pulsed field as it is collapsing. If there is a metal object in the magnetic field, the electronics unit checks the characteristics of the collapse rate against the originally produced pulses/collapse rate; thus an alarm signal is produced depending on the collapsing size of the metal target.

To ensure that the VMC1 can be used worldwide under different soil conditions, it is provided with a programme switch to set the optimum detection features. A processor internally checks the reliability and proper function of the detector during operation. The pulse signal generation, signal processing, battery voltages, external connections, and most important the internal operation voltages are constantly monitored. An acoustic alarm signal is produced when a fault is found in these functions.

This complicated procedure of measuring, operating, and controlling by the electronics unit ensures the high performance and reliability of the detector. The user is free to operate the VMC1 very easily and concentrate fully on the detection tasks.

Detectors in use

No detailed information given by the manufacturer.

Power supply

VMC1 is powered by three round cells 1.5V IEC R 14 alkaline C-size or rechargeable 1.2V C-size. The operational life of batteries is said to be as follows: approx. 8 hours depending on the age, quality and the capacity of the batteries.

Factory support

Vallon runs a worldwide servicing network with all current spare parts in stock. Spare parts can be delivered with the relevant maintenance manual directly to the customer for on-site repair.

Operation and maintenance training is offered either in the Vallon facilities or at a location required by the customer. The operation and maintenance manuals are available in English, French and German, and other languages on request.

Warranty 24 months.

Maintenance support

There are no special requirements for the technicians or the workshop facilities. All tools are standard and available in most workshops. For each detector a maintenance manual is available, with step-by-step explanation for the repair of the detector.

Test and evaluation

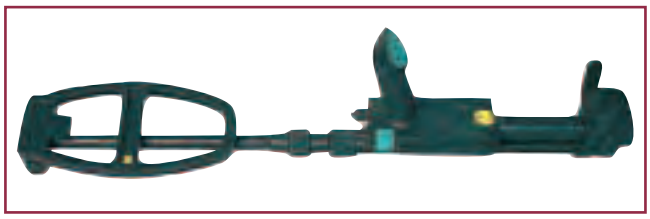
The detector has not been tested independently so far. The manufacturer allows access to several available test reports.

Reported limitations and strengths

No information due to a lack of independent test reports.

Vallon VMH3CS

Vallon GmbH, Germany



Folded Vallon VMH3CS

Length of the telescopic pole can be adjusted from 310mm to 1,250mm

General description

The **VMH3CS Mine Detector** has been designed for the detection of all types of metallic mines as well as plastic mines with minimal metal content, bombs, ammunition, and other metallic objects located in the ground or in shallow water. A 60cm search head can optionally be attached to locate buried metal-cased mines and UXO at larger depths.

The detector has a rugged design, is easy to operate and seems to be suitable for professional clearance in battlefield operations and military training programmes. The modern DMPI (Digital Magnetic Pulse Induction) and the one-piece design is the logical result from a close cooperation with professional mine clearance staff.

The operation and indication elements are integrated in the hand grip and can easily be operated with the thumb. The LED-bargraph with 12 elements is clearly visible even in the sunlight. A vibration alarm is completing the acoustic and visual alarm. A splash-proof non-magnetic loudspeaker is built in to the electronic compartment. A non-magnetic headset can be connected optionally.

VMH3CS hand grip with integrated operation and indication elements

The length of the telescopic pole can be adjusted from 910mm to 1,250mm rapidly. Along with its digital signal processor the VMH3CS works on the function principle of an advanced pulse-field, which has been optimised by Vallon. The detector can be used in strongly mineralised soils, such as laterite, magnetite, in shallow water (salt and fresh water) and under the electromagnetic influence of main power lines without affecting the detector's sensitivity too much.

Data input allows for further upgrade of the detector software, and data output enables measured data to be evaluted using VALLON EVA2000® software, running on a laptop or PC. The detector can also be connected to the Vallon Memobox MB4 and the Vallon Field Computer VFC1 dataloggers.

The detector complies to environmental conditions according to MIL STD 810F, 501.4-II, 502.4-I, 502.4-II, 503.4, 506.4-III, 514.5 C1

Main components

1. Detector electronics with integrated armrest, non-magnetic loudspeaker, power supply, battery compartment, on/off switch for two different ground conditions, and vibrator. Hand grip with visual bargraph (14 elements), three rigid push buttons for sensitivity control, volume control, and ground compensation. Two-piece telescopic carrying bar with plug-in connection for search head.
2. Watertight oval search head with carrying bar and plug-in connection to the electronics unit.
3. Non-magnetic test piece.
4. 1 set (3 EA) single cell batteries 1.5V IEC R 20/D-size alkaline, 16.5A/h each.
5. Operation manual.
6. Field manual.
7. Field backpack for storing the complete detector set VMH3CS with all accessories.

UXO search head

Optional accessories (available on request)

1. Headset.
2. Hard case for storing the complete detector set VMH3CS with all accessories.
3. UXO search head (search head with 60 cm diameter)m
4. Stick probe.

Working methodology

The search head continuously emits electromagnetic pulses as the operator sweeps close to the surface.

The search head acts as both an emitter and a receiver as it now senses the time behaviour of the pulsed field as it collapses.

If there is a metal object in the magnetic field range, the electronics unit checks the characteristics of the collapse rate against the originally produced pulses/collapse rate; thus an alarm signal is produced depending on the collapsing size of the metal target.

To ensure that the VMH3CS can be used worldwide under different soil conditions, it is provided with a programme switch to select different detection features for the actual detection job.

A processor internally checks the reliability and proper function of the detector during operation. The pulse signal generation, signal processing, battery voltages, external connections, and most importantly the internal operation voltages, are constantly monitored. An acoustic alarm signal is produced when a fault is found in these functions.

The sophisticated but rugged electronic unit ensures a high performance and reliability of the detector. As the detector is easy to handle the operator can concentrate entirely on conducting the detection task.

Power supply

VMH3CS is powered by three 1.5V mono-cells IEC R20 (ANSI std. D) or rechargeable RSH 4 KR 35/62. The operational battery life is approximately 18 to 25 hours depending on the age, quality and capacity of the batteries.

Detectors in use to date

No detailed information given by the manufacturer.

Factory support

- Vallon runs a worldwide servicing network with all current spare parts in stock. Spare parts can be delivered with a corresponding maintenance manual directly to the customer for on-site repair;

- Operation and maintenance training is offered either in the Vallon facilities or at a location required by the customer;
- The operation and maintenance manuals are available in English, French, German, and Spanish, and other languages on request;
- Warranty 24 months.

Maintenance and support

There are no special requirements for the technicians or workshop facilities. All tools are standard and available in most of the workshops. For each detector a maintenance manual is available, with step-by-step explanation for repair of the detector.

Test and evaluation

The manufacturer allows access to several available test reports.

The detector has not yet undergone independent testing. However, as the detector has the same working methodology as the VMM2 version, performance can be expected to be at least as good (see *Metal Detectors Catalogue 2003*, p. 37).

The detector has recently been tested by JRC in Laos but no detailed information is yet available. However, it will be soon published on the JRC website

Reported limitations and strengths

No information available due to a lack of independent test reports.

Vallon VMM3

Vallon GmbH, Germany

VALLON VMM3

Transport aluminium case

General description

The **VMM3 Mine Detector** has been designed for the detection of all types of metallic mines as well as plastic mines with minimal metal content, bombs, ammunition, and other metallic objects located in the ground or in shallow water. A 60cm search head can be used to locate buried metal-cased mines and UXO to greater depths.

The detector has a rugged design, is easy to operate and seems to be suitable for professional clearance in battlefield operations and military training programmes.

Along with its digital signal processor the metal detector VMM3 works on the principle of an advanced pulse-field. This working principle has been optimised by Vallon. The detector can be used in strongly mineralised soils, such as laterite, magnetite, in shallow water (salt and fresh water) and under the electromagnetic influence of main power lines without affecting the detector's sensitivity too much.

Data input allows for further upgrade of the detector software, and data output enables measured data to be evaluted using VALLON EVA2000® software, running on a laptop or PC. The detector can also be connected to the Vallon Memobox MB4 and the Vallon Field Computer VFC1 dataloggers.

The detector complies to environmental conditions according to MIL STD 810F, 501.4-II, 502.4-I, 502.4-II, 503.4, 506.4-III, 514.5 C1

Main components VMM3

1. Watertight oval search head with telescopic carrying bar (three sections) with internally running connection cable and an electronics unit consists of an integrated non-magnetic loudspeaker and a battery compartment for 4 batteries (alkaline mono cells, or Ni-Cad accumulators).
   The operating controls, essential during the detection, are all arranged at the front panel. They are protected against mechanical damage and unintentional changes.
   Programme selector with integrated on/off switch.
   Button "COMP" for automatic fine adaption to mineralised soil.
   Data connector which is normally closed by a protection cap. This data connector has two functions: (i) data input for upgrading the firmware, and (ii) data output for computer-aided detection.
2. Detection test piece (non-magnetic).
3. Batteries, 4 each (D-size).
4. Non-magnetic, watertight headset.

5. Carrying belt for the electronics unit.
6. Handle.
7. Armrest.
8. Supplementary arm-belt.
9. Operation manual.
10. Field manual.
11. Aluminum carrying case.
12. Backpack.

Optional accessories (available on request):

14. UXO search head (search head with 60cm diameter).
15. Stick probe.

Working methodology

The search head continuously emits electromagnetic pulses as the operator sweeps close to the surface.

The search head acts as both an emitter and a receiver as it senses the time behaviour of the pulsed field as it collapses.

If there is a metal object in the magnetic field, the electronic unit checks the characteristics of the collapse rate against the originally produced pulses/collapse rate; thus an alarm signal is produced depending on the collapsing size of the metal target.

To ensure that the VMM3 can be used worldwide under different soil conditions, it is provided with a programme switch to select different detection features for the actual detection job.

A processor internally checks the reliability and proper functioning of the detector during operation. The pulse signal generation, signal processing, battery voltages, external connections, and most importantly the internal operation voltages, are constantly monitored. An acoustic alarm signal is produced when a fault is found in these functions.

Front panel of the VMM3

The sophisticated but rugged electronic unit ensures a high performance and reliability of the detector. As the detector is easy to handle the operator can concentrate entirely on conducting the detection task.

Power supply

VMM 3 is powered by four 1.5V mono-cell IECLR 20 (ANSI STD size D) or rechargeable KR 35/62. The operational life of batteries is said to be approximately 30-40 hours depending on the age, quality and capacity of the batteries.

Detectors in use to date

No detailed information given by the manufacturer.

Factory support

- Vallon runs a worldwide servicing network with all spare parts in stock. Spare parts can be delivered with the relevant maintenance manual directly to the customer for on-site repair.
- Operation and maintenance training is offered either at the Vallon facilities or at a location chosen by the customer.
- The operation and maintenance manuals are available in English, French, German and Spanish, and other languages on request.

- Warranty 24 months.

Maintenance and support

There are no special requirements for the technicians or the workshop facilities. All tools are standard and available in most workshops. For each detector a maintenance manual is available, with step-by-step explanation on how to repair the detector.

Test and evaluation

The manufacturer allows access to several available test reports.

The detector has not yet undergone independent testing. However, as the detector has the same working methodology and technical specification as the VMM2 version, performance can be expected to be at least as good (see *Metal Detectors Catalogue 2003*, p. 37).

Detector with detachable electronics unit

Reported limitations and strengths

No information is available due to a lack of independent test reports.

Technical specifications — CEIA MIL-D1

Detector

1.	Brand:	CEIA
2.	Model:	MIL-D1
3.	Version:	3.3
	Used detection technology:	Electromagnetic Induction – CW (continuous wave)

Dimensional data

4.	Working length:	
	• min. length:	1,000mm
	• max. length:	1,620mm
5.	Search head:	
	• size:	External diameter: 282mm
	• weight:	0.645kg
	• shape:	Circular
6.	Transport case:	
	• weight:	7kg
	• with equipment (full):	12.5kg
	• dimensions:	975 x 450 x160mm
	• hard/soft case (material):	High impact polypropylene/synthetic canvas
7.	Weight, hand-held unit:	—
8.	Weight, carrying (operational detection set):	3.2kg
9.	Weight, additional equipment:	—
10.	Weight distribution/balance:	Well balanced – optimised for continuous operation
11.	Other specifications:	—

Detection system specifications

12.	Control of working depth:	Knob sensitivity adjustment
13.	Status:	In production
14.	Detectors/systems in use to date:	4,700
15.	Other types:	—
16.	Location of use:	Afghanistan, Egypt, Ethiopia, Finland, Iraq, Lebanon, Sweden, Thailand, and others.

Environmental influence

17.	Humidity (limitations):	No influence
18.	Temperature (limitations)	
	• storage:	-55°C to +75°C
	• operational:	-40° to +65°C
19.	Water resistant:	Yes, IP68 (IEC 529)
20.	Shock/vibration resistant:	Yes, exceeding MIL STD 810 E
21.	Environmental compensation:	Auto
	Operational hours/operating endurance	
	• low temperature (around 0°C):	MTBF = 27,500[1]
	• medium temperature (around 20°C):	MTBF = 22,500[1]
	• high temperature (higher than 30°C):	At 35°C MTBF = 18,000[1]

Detection specifications

22.	Calibration/set-up	
	• auto/manual:	Auto
	• duration:	No limit
23.	Detection range/sensitivity details/ detection performance/working depth	
	• low-metal-content mines:	Optimised according to the devices and soils
	• anti-vehicle mines:	Optimised according to the devices and soils
	• UXO:	Optimised according to the devices and soils
24.	Output indicator:	Sound (display as option)
25.	Pinpointing feature:	Dual tone
26.	Adjustment of search head angle:	0° up to 97°
27.	Soil influence:	Self-learning compensated

28.	Best use in:	
	• sand:	Yes
	• peat:	Yes
	• clay:	Yes
	• ferruginous soil (laterite):	Yes
29.	Optimal sweep speed:	From 0cm/s to to the maximum human operator sweep
30.	Search coil/antenna:	Circular
31.	Limitations:	—
32.	Interference (with other detectors):	—

Power

33.	Power supply/source:	4 x 1.5V alkaline batteries or 4 x 1.2V Ni-Mh rechargeable batteries
34.	Operating time:	> 65h with alkaline batteries; > 35h with rechargeable batteries
35.	Power supply:	
	• weight:	Total for no. 4 batteries: 0.580kg (alkaline batteries)/ 0.61kg (rechargeable batteries)
	• no. of batteries/size/type:	4 /ANSI std D – IEC std LR20/alkaline or rechargeable
	• rechargeable:	Yes
	• other:	—

Costs

36.	Price:	
	• for one detector:	Not provided
	• reduction for higher quantity:	—
37.	System price	
	• with training:	—
	• spare parts:	—
	• extended warranty:	—
38.	Total:	—
39.	Availability for hire:	—

Others

40.	Duration of warranty:	—
41.	Additional equipment:	Battery charger MIL-D1/BC
42.	additional technical data/information:	On request
46.	Compliant standards:	MIL-STD 810 E and others on request

1. According to MIL-HDBK 217.

Technical specifications — Ebinger EBEX® 420 H-Solar

Detector:

1.	Brand:	Ebinger
2.	Model:	EBEX® 420 H
3.	Version:	01/2002
4.	Used detection technology:	Metal detector/sine wave

Dimension data:

5.	Working length:	
	• min. length:	670mm (short version)
	• max. length:	1,840 mm (long version)
6.	Search head:	
	• size:	Ø 200mm
	• weight:	0.5kg
	• shape:	Circular
7.	Transport case	
	• weight:	2kg
	• with equipment:	5kg
	• dimension:	—
	• hard/soft case:	Hard plastic / canvas satchel
8.	Weight, hand-held unit:	0.88kg (short)/1.45kg (long)
9.	Weight, carrying(operational detection set)	0.88kg (short)/1.45kg (long)
10.	Weight, additional equipment:	—
11.	Weight distribution/balance:	—
12.	Other specifications:	Modular systems without any cables

Detection system specifications

13.	Control of working depth:	Sensitivity adjustment manual
14.	Status:	In production
15.	Detectors/systems in use to date	Approx. 2,000
16.	Other types:	—
17.	Location of use:	Worldwide

Environmental influence

18.	Humidity (limitations):	0-95%
19.	Temperature (limitations):	
	• storage:	-53°C to +70°C
	• operational:	-30°C to +55°C
20.	Water resistant:	Yes up to 1.3m
21.	Shock/vibration resistant:	Yes
22.	Environmental compensation	Manual
23.	Operational hours/operating endurance:	
	• low temperature (around 0°C):	Up to 75h, depends on solar radiation
	• medium temperature (around +20°C):	up to 75h, depends on solar radiation
	• high temperature (around +30°C):	up to 75h, depends on solar radiation

Detection specifications

24.	Calibration/set-up:	
	• auto / manual:	Manual
	• duration	Continual
25.	Detection range/sensitivity details/ detection performance/working depth	
	• low-metal-content mines:	Depending on their size, material and the local interference
	• anti-vehicle mines:	Depending on their size, material and the local interference
	• UXO	Depending on their size, material and the local interference
26.	Output indicator:	Sound
27.	Pinpointing feature:	Yes
28.	Adjustment of search head angle:	Yes
29.	Soil influence:	—

30.	Best use in	
	• sand	Yes
	• peat	Yes
	• clay	Yes
	• ferruginous soil (laterite)	No
31.	Optimal sweep speed:	0.2-1.5m per second
32.	Search coil / antenna:	Ø 200mm circular
33.	Limitations:	No
34.	Interference (with other detectors):	< safety distance

Power

35.	Power supply/source	Battery
36.	Operation time:	See point 23
37.	Power supply:	
	• weight:	
	• no of batteries:	1 x 9V dry battery LR61
	• rechargeable:	1 x 9V rechargeable LR61
	• other:	Power supply from solar panel

Costs

38.	Price:	
	• for one detector:	US$1,000 - US$2,000
	• reduction for higher quantity:	Yes
39.	System price	
	• with training:	On request
	• spare parts:	On request
	• extended warranty:	On request
40.	Total:	—
41.	Availability for hire:	On request

Other

42.	Duration of warranty:	24 months
43.	Additional equipment:	Extension rod
44	Additional technical data/information:	—
46.	Compliant standards:	MIL-STD 461, MIL-STD 810, DIN EN ISO 900: 2000

Technical specifications — Ebinger EBEX® 420 PBD

Detector:

1.	Brand:	Ebinger
2.	Model:	EBEX® PBD (stands for Pulse Bipolar Dynamic)
3.	Version:	11/1996
4.	Used detection technology:	Metal detector/pulse induction

Dimension data:

5.	Working length:	
	• min. length:	1,080mm (short version)
	• max. length:	1,650mm (long version)
6.	Search head:	
	• size:	Ø 260 x 156mm
	• weight:	0,5kg
	• shape:	Oval
7.	Transport case:	
	• weight:	2kg
	• with equipment:	8.5kg
	• dimension:	—
	• hard/soft case (material):	Hard plastic/canvas satchel
8.	Weight, hand-held unit:	2.2kg (short)/2.4kg (long)
9.	Weight, carrying(operational detection set):	2.2kg (short)/2.4kg (long)
10.	Weight, additional equipment:	—
11.	Weight distribution/balance:	—
12.	Other specifications:	Modular systems without any cables

detection system specifications

13.	Control of working depth:	Sensitivity adjustment manual
14.	Status:	In production
15.	Detectors/systems in use to date:	Approx. 5,000
16.	Other types:	—
17.	Location of use:	Worldwide

Environmental influence

18.	Humidity (limitations):	0-95%
19.	Temperature (limitations)	
	• storage	-53°C to +70°C
	• operational:	-30°C to +55°C
20.	Water resistant:	Yes up to 1.3m
21.	Shock/vibration resistant:	Yes
22.	Environmental compensation:	Auto / manual
23.	Operational hours/operating endurance:	
	• low temperature (around 0°C):	Up to 50h, depends on type of battery
	• medium temperature (around +20°C):	Up to 50h, depends on type of battery
	• high temperature (around +30°C):	Up to 50h, depends on type of battery

Detection specifications

24.	Calibration/set-up	
	• auto / manual	Manual or automatic
	• duration	Continual
25.	Detection range/sensitivity details/ detection performance working depth	
	• low-metal-content mines:	Depending on their size, material and the local interference
	• anti-vehicle mines:	Depending on their size, material and the local interference
	• UXO	Depending on their size, material and the local interference
26.	Output indicator:	Sound
27.	Pinpointing feature:	Yes
28.	Adjustment of search head angle:	Yes
29.	Soil influence:	

30.	Best use in:	
	• sand:	Yes
	• peat:	Yes
	• clay:	Yes
	• ferruginous soil (laterite):	Under certain circumstances
31.	Optimal sweep speed:	0,2-1,5m/s
32.	Search coil / antenna:	Ø 260 x 156mm oval
33.	Limitations:	No
34.	Interference (with other detectors):	< safety distance

Power

35.	Power supply/source:	Battery
36.	Operation time:	See point 23
37.	Power supply:	
	• weight:	—
	• no of batteries:	6 x 1.5V dry batteries C-cell
	• rechargeable:	6 x 1.2V rechargeable batteries
	• other:	1 x 12V battery pack

Costs

38.	Price:	
	• for one detector:	US$2,000-US$3,000
	• reduction for higher quantity:	Yes
39.	System price:	
	• with training:	On request
	• spare parts:	On request
	• extended warranty:	On request
40.	Total:	—
41.	Availability for hire:	On request

Other

42.	Duration of warranty:	24 months
43.	Additional equipment:	UXO head □ 45cm, cylinder probe
44	Additional technical data/information:	-
46.	Compliant standards:	MIL-STD 461,MIL-STD 810, DIN EN ISO 9001:2000

Technical specifications — Ebinger EBEX® 421 GC

Detector:

1.	Brand:	Ebinger
2.	Model:	EBEX® 421 GC (stands for Ground Compensation)
3.	Version:	11/2002
4.	Used detection technology:	Metal detector/pulse induction

Dimensional data:

5.	Working length:	
	• min. length:	1,000mm (short version)
	• max. length:	1,700mm (long version)
6.	Search head:	
	• size:	Ø 230mm (300 x 170mm)
	• weight:	0.5kg
	• shape:	Circular, oval
7.	Transport case	
	• weight:	2kg
	• with equipment	3.8kg/8.5kg
	• dimension	—
	• hard/soft case (material)	Hard plastic/canvas satchel
8.	Weight, hand-held unit:	2.2kg (short)/2.4 kg (long)
9.	Weight, carrying(operational detection set):	2.2kg (short) /2.4 kg (long)
10.	Weight, additional equipment:	—
11.	Weight distribution/balance:	—
12.	Other specifications:	Modular systems without any cables

Detection system specifications

13.	Control of working depth:	Sensitivity adjustment manual
14.	Status:	In production
15.	Detectors/systems in use to date	Approx. 2,000
16.	Other types:	—
17.	Location of use:	Worldwide

Environmental influence

18.	Humidity (limitations):	0-95%
19.	Temperature (limitations)	
	• storage	-53°C to +70°C
	• operational:	-30°C to +55°C
20.	Water resistant:	Yes, up to 1.3m
21.	Shock/vibration resistant:	Yes
22.	Environmental compensation:	Auto/manual
23.	Operational hours/operating endurance:	
	• low temperature (around 0°C):	Up to 75h, GC mode up to 25h, depends on type of battery
	• medium temperature (around +20°C):	Up to 75h, GC mode up to 25h, depends on type of battery
	• high temperature (around +30°C):	up to 75h, GC mode up to 25h, depends on type of battery

Detection specifications

24.	Calibration/set-up:	
	• auto / manual	Manual or automatic
	• duration	Continual
25.	Detection range/sensitivity details/ detection performance/working depth	
	• low-metal-content mines:	Depending on their size, material and the local interference
	• anti-vehicle mines:	Depending on their size, material and the local interference
	• UXO:	Depending on their size, material and the local interference
26.	Output indicator:	Sound
27.	Pinpointing feature:	Yes
28.	Adjustment of search head angle:	Yes
29.	Soil influence:	Specially developed for laterite soil

30.	Best use in:	
	• sand	Yes
	• peat	Yes
	• clay	Yes
	• ferruginous soil (laterite)	Yes
31.	Optimal sweep speed:	0,2-1,5m/s
32.	Search coil / antenna:	Ø 230mm circular, (300 x 170mm oval)
33.	Limitations:	No
34.	Interference (with other detectors):	< safety distance

Power

35.	Power supply/source	Battery
36.	Operation time:	See point 23
37.	Power supply:	
	• weight:	—
	• no of batteries:	8 x 1.5V dry batteries C-cell
	• rechargeable:	8 x 1.2V rechargeable batteries
	• other:	1 x 12V battery pack

Costs

38.	Price:	
	• for one detector:	US$2,000 - US$3,000
	• reduction for higher quantity:	Yes
39.	System price	
	• with training:	On request
	• spare parts:	On request
	• extended warranty:	On request
40.	Total	—
41.	Availability for hire:	On request

Other

42.	Duration of warranty	24 months
43.	Additional equipment:	UXO head □ 45cm
44	Additional technical data/information:	—
46.	Compliant standrds:	MIL-STD 461,MIL-STD 810, DIN EN ISO 9001:2000

Technical specifications — Foerster Minex 2FD 4.500

Detector

1.	Brand:	Foerster
2.	Model:	Minex
3.	Version:	Minex 2FD 4.500
4.	Used detection technology:	Metal detector working by continuous wave EMI with two parallel frequencies in combination with a gradiometric coil system.

Dimensional data

5.	Working length	
	• min. length:	920mm
	• max. length:	1,670mm
6.	Search head	
	• size:	210 x 285mm
	• weight:	n/a since forming part of the one-piece unit
	• shape:	Oval
7.	Transport case	
	• weight	4kg
	• with equipment (full):	Approx. 7kg
	• dimensions:	97 x 24 x 37cm
	• hard/soft case (material):	Hardcase/plastics (optional backpack)
8.	Weight, hand-held unit:	2.15kg (2.55kg including batteries)
9.	Weight, carrying (operational detection set):	2.55kg
10.	Weight, additional equipment:	Backpack 0.8kg , headphones 0.1kg
11.	Weight distribution/balance:	Balanced around the handgrip
12.	Other specifications:	—

Detection system specifications

13.	Status:	In production
14.	Detectors/systems in use to date:	No information provided by the manufacturer
15.	Other types:	Modified Soil Compensation Programme (Minex 2FD 4.500 AFG)
16.	Location of use:	Afghanistan

Environmental influence

17.	Humidity (limitations):	No limitations
18.	Temperature (limitations)	
	• storage:	- 57°C to + 71°C (-135°F to +160°F)
	• operational:	- 37°C to + 71°C (-99°F to +160°F)
19.	Water resistant:	Search head and telescope waterproof. Electronic unit (upper approx. 30cm of the total unit) is highly splash-proof. See Mil-STD Specs.
20.	Shock/vibration resistant:	See MIL-STD Specs.
21.	Environmental compensation:	Automatic, control of very aggressive soil supported by manual push-button operation.
22.	Operational hours/operating endurance	
	•low temperature (around 0°C):	Depending on working rhythm, approx. 25h with alkaline batteries
	• medium temperature (around 20°C):	Depending on working rhythm, approx. 30-50h with alkaline batteries
	• high temperature (higher than 30°C):	Depending on working rhythm, approx. 30-50h with alkaline batteries

Detection specifications

23.	Calibration/set-up	
	• auto/manual:	Automatic; manual control with test piece
	• duration:	30 seconds
24.	Detection range/sensitivity details/ detection performance/working depth	
	• low-metal-content mines:	Type 72A - approx. 18cm

	• anti-vehicle mines:	TM 62 M - down to approx. 60cm
	• UXO:	See anti-vehicle mine for exemplary comparison on bigger objects; for UXO search Foerster offers highly-specialised magnetometers
25.	Output indicator:	Audio by inbuilt speaker or headphones
26.	Pinpointing feature:	Two sounds, switching when passing an object with the centre of the search head
27.	Adjustment of search head angle:	Manual
28.	Soil influence:	Up to a certain degree automatic adaptation, aggressive soil can be learned by pushing a button.
29.	Best use in	
	• sand:	Yes
	• peat:	Yes
	• clay:	Yes
	• ferruginous soil (laterite)	Yes
30.	Optimal sweep speed:	Signal-quality not speed-dependent, no particular limit
31.	Search coil/antenna:	Gradiometric coil system (one sending/two receiving coils) Printed multi-layer construction
32.	Limitations:	Not usable by divers
33.	Interference (with other detectors):	Within approx. 5m

Power

34.	Power supply/source:	Batteries
35.	Operating time:	25-50h with alkaline batteries
36.	Power supply	
	• weight:	n/a since forming part of the one-piece unit
	• no. of batteries/size/type:	3 x 1.5V mono-cell IECLR (ANSI STD.size D)
	• rechargeable:	Possible

Costs

37.	Price:	
	• for one detector:	Between US$2,000 and US$3,000
	• reduction for higher quantity:	Yes
38.	System price	
	• with training:	Depending on quantity
	• spare parts:	Depending on quantity
	• extended warranty:	Available on request
39.	Total:	t.b.d.
40.	Availability for hire:	Available

Others

41.	Duration of warranty:	24 months
42.	Additional equipment:	Headphones, backpack, workshop equipment and tools
43.	additional technical data/information:	Service manuals, training programme
44.	Compliant standards:	MIL-STD 810E 514.4-1 random vibration MIL-STD 810E 516.4 mechanical shock MIL-STD 810E 516.4 drop test MIL-STD 810E 501.3 high temperatures MIL-STD 810E 502.3 low temperatures MIL-STD 810E 506.3-1 blowing rain MIL-STD 810E 503.3 temperature shock MIL-STD 810E 512.2 leakage test MIL-STD 810E 505.3 solar radiation (sunshine) procedure I Mission MTBF = 24 480h (in accordance to MIL-STD-217F) EMC according to EN 55022:1998 (Class B) and EN 61000-4-3:1996+A1:1998

Technical specifications — Geophex GEM-3

Detector

1.	Brand:	Geophex
2.	Model:	GEM-3
3.	Version:	—
4.	Used detection technology:	Frequency broadband electromagnetic sensor

Dimensional data

5.	Working length:	
	• min. length:	50cm
	• max. length:	2m
6.	Search head:	
	• size:	25-40cm
	• weight:	500g
	• shape	circular
7.	Transport case	
	• weight:	4kg
	• with equipment (full):	5kg
	• without equipment (empty):	2kg
	• dimensions:	40 x 30 x 10cm
	• material:	Plastic
8.	Weight, handheld unit:	3kg
9.	Weight, carrying (operational detection set):	3kg
10.	Weight, additional equipment:	0
11.	Other specifications:	—

Detection system specifications

12.	Control of working depth:	50cm
13.	Status:	In production
14.	Detectors/systems in use to date:	About 50
15.	Other types:	—
16.	Location of use:	Worldwide

Environmental influence

17.	Humidity (limitations):	Up to 95%
18.	Temperature (limitations)	
	• storage:	-20 to 50° C
	• operational:	-20 to 50° C
19.	Water resistant:	Yes
20.	Shock/vibration resistant:	Yes
21.	Environmental compensation:	Manual
22.	Operational hours/operating endurance:	
	• low temperature (around 0°C):	4h
	• medium temperature (around 20°C):	8h
	• high temperature (higher than 30°C):	6h

Detection specifications

23.	Calibration/setup	
	• auto/manual:	Auto
	• duration:	Months
24.	Detection range/sensitivity details/ detection performance/working depth	
	• low metal content mines:	M14 at15cm
	• anti-vehicle mines:	VS2.2 at 30cm
	• UXO:	155mm round at 120cm
25.	Signal	
	• audio:	Yes
	• visual:	Yes
	• other:	—
26.	Soil influence:	Can be compensated

27.	Best use in:	
	• sand	Excellent
	• peat	Excellent
	• clay	Good
	• ferruginous soil (laterite)	Good
28.	Optimal sweep speed:	50cm/s
29.	Search coil/antenna:	25-40cm circular
30.	Limitations:	None
31.	Interference (with other detectors):	Minimal

Power

32.	Power supply/source:	Internal rechargeable 12VDC battery
33.	Operating time:	8h nominal
34.	Power supply	
	• weight:	0.8kg
	• no of batteries/size/type:	One: 10 x 15 x 1.5cm
	• rechargeable:	Yes

Costs

35.	Price:	Contact Geophex for latest prices
36.	System price	More than US$ 5,000, reduction for higher quantity
	• with training:	Contact Geophex
	• spare parts:	Contact Geophex
	• extended warranty:	Contact Geophex
37.	Availability for hire:	Yes

Others

38.	Duration of warranty:	90 days
39.	Additional equipment:	Discrimination software on Windows or Windows CE
40.	Additional technical data/information:	Yes
41.	Compliant standards	Civil

Technical specifications — Guartel MD8+

Detector

1.	Brand:	Guartel Technologies Ltd
2.	Model:	MD8+
3.	Version:	—
4.	Used detection technology:	Pulse induction

Dimensional data

5.	Working length:	
	• min. length:	1,120mm
	• max. length:	1,560mm
6.	Search head:	
	• size:	200mm
	• weight:	1,100kg
	• shape	Oval
7.	Transport case	
	• material:	Cordura haversack
8.	Weight, handheld unit:	—
9.	Weight, carrying (operational detection set):	3kg
10.	Weight, additional equipment:	—
11.	Other specifications:	—

Detection system specifications

12.	Control of working depth:	Automatic
13.	Status:	In production
14.	Detectors/systems in use to date:	—
15.	Other types:	—
16.	Location of use:	Angola, Balkans, Democratic Republic of Congo, Iraq, Kuwait, South Africa

Environmental influence

17.	Humidity (limitations):	Fully sealed
18.	Temperature (limitations)	
	• storage:	-25 to 60° C
	• operational:	-25 to 60° C
19.	Water resistant:	Yes
20.	Shock/vibration resistant:	Yes
21.	Environmental compensation:	Automatic
22.	Operational hours/operating endurance:	
	• low temperature (around 0°C):	16h
	• medium temperature (around 20°C):	18h
	• high temperature (higher than 30°C):	16h

Detection specifications

23.	Calibration/setup	
	• auto/manual:	Auto
	• duration:	—
24.	Detection range/sensitivity details/ detection performance/working depth	
	• low-metal-content mines:	Type 72 at 100mm
	• anti-vehicle mines:	MK7 at 700mm
	• UXO:	81mm mortar at 800mm
25.	Output indicator:	Sound and display via LEDs
26.	Pinpointing feature:	Sound and display
27.	Soil influence:	—
28.	Best use in:	
	• sand	Yes
	• peat	Yes
	• clay	Yes
	• ferruginous soil (laterite)	Limited

29.	Search coil/antenna:	Differential RX coil
30.	Limitations:	—
31.	Interference (with other detectors):	—

Power

32.	Power supply/source:	3 X LR20D cell manganese alkaline
33.	Operating time:	—
34.	Power supply	
	• weight:	—
	• no of batteries/size/type:	—
	• rechargeable:	Can be used but will reduce operating time by 50 per cent

Costs

35.	Price:	£1,450 (approx. US$2,800), reduction for higher quantity
36.	System price	More than US$5,000, reduction for higher quantity
	• with training:	On request
	• spare parts:	On request
	• extended warranty:	On request
37.	Availability for hire:	Yes

Others

38.	Duration of warranty:	120 months
39.	Additional equipment:	Probe and short halo
40.	Additional technical data/information:	—
41.	Compliant standards	Military

Technical specifications — Minelab F1A4

Detector

1.	Brand:	Minelab
2.	Model:	F1A4
3.	Version:	Version 8
4.	Used detection technology:	Pulse induction

Dimensional data

5.	Working length	
	• min. length:	1,200mm
	• max. length:	1,450mm
6.	Search head	
	• size:	200mm diameter
	• weight:	—
	• shape	Circular - monoloop
7.	Transport case	
	• weight:	4kg
	•with equipment (full):	8kg
	•dimensions:	320mm x 840mm x 180mm
	• hard/soft case (material):	Impact plastic/cordura
8.	Weight, hand-held unit:	1.5kg
9.	Weight, carrying (operational detection set):	3kg
10.	Weight, additional equipment:	—
11.	Weight distribution/balance:	Adjustable
12.	Other specifications:	—

Detection systems specifications

13.	Status:	In production
14.	Detectors/systems in use to date:	More than 6,000
15.	Other types:	F1A4 MIM, F1A4 UXO
16.	Location of use:	45 countries

Environmental influence

17.	Humidity (limitations):	Nil
18.	Temperature (limitations)	
	• storage:	-30°C to + 60°C
	• operational:	—
19.	Water resistant:	Yes (control box IP65)
20.	Shock/vibration resistant:	Yes
21.	Environmental compensations:	Auto
22.	Operational hours/operating endurance	
	• low temperature (around 0° C):	—
	• medium temperature (around 20° C):	16h
	• high temperature (higher than 30° C):	—

Detection specifications

23.	Calibration/set-up	
	•auto/manual	Auto
	• duration	—
24.	Detection range/sensitivity details/ detection performance/working depth	
	• low metal content mines:	Type 72 at 15-19cm
	• anti-vehicle mines:	500lb bomb at 1.8m
	• UXO:	—
25.	Output indicator:	Audio
26.	Pinpointing feature:	Edge detection
27.	Adjustment of search head angle:	Yes
28.	Soil influence:	Automatic rejection
29.	Best use in:	Independent of soil type
30.	Optimal sweep speed:	0.6m/s
31.	Search coil	Enclosed

32.	Limitations:	—
33.	Interference (with other detectors)	3-4m

Power

34.	Power supply/source:	4 x D cell alkaline/Ni-Cad batteries
35.	Operating time:	Alkaline batteries 16h
36.	Power supply:	4 x D cell
	• weight:	800g
	• no. of batteries/size/type:	4 x D cell alkaline
	• rechargeable	4 x D cell
	• other	

Costs

37.	Price	
	• for one detector:	US$1,000-US$2,000
	• reduction for higher quantity	Yes
38.	System price	
	• with training	Yes (subject to quantity purchased)
	• spare parts	Available
	• extended warranty	Yes
39.	Total:	Included free of charge for quantity purchase
40.	Availability for hire:	No

Others

41.	Duration of warranty:	15 months
42.	Additional equipment:	F series battery charger
43.	Additional technical data/information:	—
44.	Compliant standards:	Military specifications

Technical specifications — Minelab F3

Detector

1.	Brand:	Minelab
2.	Model:	F3
3.	Version:	New release
4.	Used detection technology:	Bipolar pulse induction

Dimensional data

5.	Working length	
	• min length:	650mm
	•max length:	1,500mm
6.	Search head	
	• size	200mm
	• weight	—
	• shape	Circular - monoloop
7.	Transport case	
	• weight:	4kg
	• with equipment (full):	8kg
	• dimensions:	850 x 400 x 185mm
	• hard/soft case (material):	Cordura
8.	Weight, hand-held unit:	2.1kg (battery pack removed)
9.	Weight, carrying (operational detection set):	3kg
10.	Weight, additional equipment:	—
11.	Weight distribution/balance:	Adjustable
12.	Other specifications:	—

Detection system specifications

13.	Status :	Initial production
14.	Detectors/systems in use to date:	—
15.	Other types:	—
16.	Location of use:	—

Environmental influence

17.	Humidity (limitations):	Nil
18.	Temperature (limitations):	
	• storage:	-30°C to +60°C
	• operational:	—
19.	Water resistant:	Waterproof
20.	Shock/vibration resistant:	Yes
21.	Environmental compensations :	Automatic
22.	Operational hours/operating endurance	
	• low temperature (around 0° C)	—
	•medium temperature (around 20° C)	19h (continuous use)
	• high temperature (higher than 30° C)	—

Detection specifications

23.	Calibration/set-up	
	• auto/manual	Automatic
	• duration	—
24.	Detection range/sensitivity details/detection performance/working depth	
	• low-metal-content mines:	Type 72: 15-19cms
	• anti-vehicle mines:	500lb – 1.8m
25.	Output indicator:	Audio
26.	Pinpointing feature:	DC couple edge detection
27.	Adjustment of search head angle:	Yes
28.	Soil influence:	Automatic rejection
29.	Best use in:	Independent of soil type
30.	Optimal sweep speed:	Not applicable
31.	Search coil:	Enclosed monoloop
32.	Limitations:	Nil
33.	Interference (with other detectors):	2-3m

Power

34.	Power supply/source:	4 x D cell alkaline/Ni-Cad
35.	Operating time:	19h
36.	Power supply	
	• weight:	1kg
	• no. of batteries/size/type	4 x D cell
	• rechargeable	4 x D cell
	• other:	—

Costs

37.	Price	
	• for one detector:	Less than US$2,500 (without VAT, including transport case and earphones)
	• reduction for higher quantity:	Yes
38.	System price	
	• with training:	Yes (subject to quantity purchased)
	• spare parts:	Available
	• extended warranty:	Yes
39.	Total:	
40.	Availability for hire:	No

Others

41.	Duration of warranty:	15 months
42.	Additional equipment:	F Series battery charge – UXO coil (in development)
43.	Additional technical data/information:	—
44.	Compliant standards:	Military specifications

Technical specifications — Schiebel AN-19/2 Mine Detecting Set

Detector

1.	Brand:	Schiebel
2.	Model:	An-19/2 Mine Detecting Set
3.	Version:	Mod 7
4.	Used detection technology:	Electromagnetic pulse induction

Dimensional data

5.	Working length	
	• min. length:	1,400mm
	• max. length:	1,600mm
6.	Search head	
	• size:	267mm diameter
	• weight:	0.6 kg
	• shape:	Round
7.	Transport case	
	• weight:	2.2kg
	• with equipment (full):	6.02kg
	• dimensions:	802 x 315 x125mm
	• hardcase (material):	Metal
	• soft material, backpack carry bag with accessories and detector:	4kg
8.	Weight, hand-held unit:	Search head with telescopic pole 1.22kg
9.	Weight, carrying (operational detection set):	2.41kg + set of batteries 0.58kg
10.	Weight, additional equipment:	—
11.	Weight distribution/balance:	Electronic unit is shoulder-strap mounted, headphone on head, and hand-held item is balanced by the armrest.
12.	Other specifications:	—

Detection system specifications

13.	Status:	In production
14.	Detectors/systems in use to date:	More than 40,000
15.	Other types:	—
16.	Location of use:	Worldwide

Environmental influence

17.	Humidity (limitations):	No
18.	Temperature (limitations)	Virtually none
	• storage:	-55°C to +85°C (-67°F to +185°F)
	• operational:	-40°C to +70°C (-40°F to +158°F)
19.	Water resistant:	Yes
20.	Shock/vibration resistant:	Yes
21.	Environmental compensation :	Auto
22.	Operational hours/operating endurance	
	• low temperature (around 0°C):	Approx. 65h
	• medium temperature (around 20°C):	Approx. 70h
	• high temperature (higher than 30°C):	75h or more

Detection specifications

23.	Calibration/set-up:	
	• auto/manual:	Calibration not required. Manual set-up using single control for sensitivity. Sound may also be adjusted to suit local conditions.
	• duration:	Less than 30s
24.	Detection range/sensitivity details/detection performance/working depth	
	• low-metal-content mines:	72A – 18cm, M14 – 14cm
	•anti-vehicle mines:	Metal anti-vehicle at 1m; plastic anti-vehicle : nearly all types at operational threat depth
	• UXO:	NATO standard 7.62 rounds at 40cm, AK 47 at 30+cm; all larger items down to 1m in depth

25.	Output indicator:	Sound and optional visual-led display
26.	Pinpointing feature:	Yes by edge of target warbling tone
27.	Adjustment of search head angle:	Easily adjusted by angel wingnut to cover all necessary operational situations (more than 180 degrees)
28.	Soil influence:	Can operate in light magnetic soil with reduced but normally acceptable performance
29.	Best use in:	
	• sand:	Yes
	• peat:	Yes
	• clay:	Yes
	• ferruginous soil (laterite):	No
30.	Optimal sweep speed:	Static to 2m/s
31.	Search coil:	Yes
32.	Limitations:	Medium and heavy (strong) magnetic soil
33.	Interference (with other detectors):	None at distance above 2m separation

Power

34.	Power supply/source:	Standard D size alkaline cells
35.	Operating time:	Approx. 70h
36.	Power supply:	
	• weight:	0.58kg
	• no. of batteries/Size/Type:	4 x 1.5V R20 ANSI size D
	• rechargeable:	Rechargeable Ni-Cad cells can be used but operating time is reduced to 38h

Costs

37.	Price:	
	• for one detector:	•2,000-•3,000
	• reduction for higher quantity:	Yes
38.	System price:	
	• with training:	—
	• spare parts:	—
	• extended warranty:	—
39.	Total:	—
40.	Availability for hire:	—

Others

41.	Duration of warranty:	12 months, extension possible
42.	Additional equipment:	—
43.	Additional technical data/information:	—
44.	Compliant standards:	ISO-9001, AQA P4

Technical specifications

Schiebel ATMID™ All Terrain Mine Detector

Detector

1.	Brand:	Schiebel
2.	Model:	ATMID All Terrain Mine Detector
3.	Version:	—
4.	Used detection technology:	Electromagnetic pulse and continuous wave induction

Dimensional data

5.	Working length	
	• min. length:	1,400mm
	• max. length:	1,600mm
6.	Search head	
	• size:	267mm diameter
	• weight:	0.82kg
	• shape:	Round
7.	Transport case	
	• weight:	2.2kg
	• with equipment (full):	6.36kg
	• dimensions:	802 x 315 x 125mm
	• hard/soft case (material):	Metal
8.	Weight, hand-held unit:	1.61kg
9.	Weight, carrying (operational detection set):	3.27kg including set of batteries
10.	Weight, additional equipment :	Headphone 0.17kg
11.	Weight distribution/balance:	Electronic unit is shoulder-strap mounted, headphone on head and hand-held item is balanced by the armrest.
12.	Other specifications:	—

Detection system specifications

13.	Status:	In production
14.	Detectors/systems in use to date:	More than 900
15.	Other types:	AN-19/2 various, MIMID
16.	Location of use:	Worldwide

Environmental influence

17.	Humidity (limitations):	No
18	Temperature (limitations)	
	• storage:	-55°C to +85°C
	• operational:	-40°C to +70°C
19.	Water resistant:	Yes
20.	Shock/vibration resistant:	Yes
21.	Environmental compensation:	Auto
22.	Operational hours/operating endurance	
	• low temperature (around 0°C):	Approx. 65h
	• medium temperature (around 20°C):	approx. 70h
	• high temperature (higher than 30°C):	Approx. 75h

Detection specifications

23.	Calibration/set-up	
	• auto/manual:	Automatic ground balance; manually initiated and sensitivity then manually adjusted by a single control
	• duration:	Approx. 30s
24.	Detection range/sensitivity details/ detection performance/working depth	
	• low-metal-content mines:	Type 72A - 20cm, M14 – 16cm
	• anti-vehicle mines:	Metal anti-vehicle at down to 1m, plastic anti-vehicle nearly
all		types at operational threat depth
	• UXO:	NATO standard 7.62 rounds, at 40+cm, larger items down to 1m in depth
25.	Output indicator (sound/display/other):	Audio tone
26.	Pinpointing feature:	Yes

27.	Adjustment of search head angle:	Easily adjusted by angel wingnut to cover all necessary operational situations (more than 180 degrees)
28.	Soil influence:	Automatically balanced out
29.	Best use in	
	• sand	Yes
	• peat	Yes
	• clay	Yes
	• ferruginous soil (laterite)	Yes
30.	Optimal sweep speed:	0.25-0.7metres per second
31.	Search coil/antenna:	Search coil
32.	Limitations:	Proximity to high power rf/radar transmitters
33.	Interference (with other detectors):	Mutual interference possible up to 8m in CW mode

Power

34.	Power supply/source:	Battery DC voltage
35.	Operating time:	Approx. 70h
36.	Power supply	
	• weight:	0.58kg
	• no. of batteries/size/type:	4 x 1.5V R20 ANSI size D cells
	• rechargeable:	Ni/Cad 1.5V

Costs

37.	Price:	
	• for one detector:	•2,000 - •3,000
	• reduction for higher quantity:	Yes
38.	System price	
	• with training:	—
	• spare parts:	—
	• extended warranty:	—
39.	Total:	—
40.	Availability for hire:	—

Others

41.	Duration of warranty:	12 months
42.	Additional equipment:	—
43.	Additional technical data/information:	—
44.	Compliant standards:	ISO 9001, AQAP 4

Technical specifications

Schiebel MIMID™ Miniature Mine Detector

Detector

1.	Brand:	Schiebel
2.	Model:	MIMID™ Miniature Mine Detector
3.	Version:	—
4.	Used detection technology:	Electromagnetic pulse induction

Dimensional data

5.	Working length	
	• min. length:	656mm
	• max. length:	1,262mm
6.	Search head	
	• size:	328mm
	• weight:	Integrated in mine detector
	• shape:	Rectangular
7.	Transport case	
	• weight:	0.64kg
	• with equipment (full):	2kg
	• dimensions:	328 x 102 x 56mm
	• hard/soft case (material):	Soft
8.	Weight, hand-held unit:	1.36kg
9.	Weight, carrying (operational detection set):	1.36kg + set of batteries 0.1kg
10.	Weight, additional equipment:	Mine prodder
11.	Weight distribution/balance:	Various. All of the weight is hand-held but the unit is counterbalanced at the handle by the entire armrest.
12.	Other specifications:	—

Detection system specifications

13.	Status:	In production
14.	Detectors/systems in use to date:	More than 1,500
15.	Other types:	—
16.	Location of use:	Worldwide

Environmental influence

17.	Humidity (limitations):	No
18.	Temperature (limitations)	
	• storage:	+55°C to +85°C
	• operational:	-40°C to +70°C
19.	Water resistant:	Waterproof to 30m
20.	Shock/vibration resistant:	Yes
21.	Environmental compensation:	Auto
22.	Operational hours/operating endurance	
	• low temperature (around 0°C):	Approx. 6.5h
	• medium temperature (around 20°C):	Approx. 7h
	• high temperature (higher than 30°C):	Approx. 7.5h

Detection specifications

23.	Calibration/set-up:	
	• auto/manual:	Calibration not required. Manual set-up using single control for sensitivity. Sound may also be adjusted to suit local conditions.
	• duration:	Less than 30s
24.	Detection range/sensitivity details/detection performance/working depth	
	• low-metal-content mines :	Type 72 A - 14cm; M14 – 12cm
	• anti-vehicle mines:	Metallic mines down to 80cm - plastic mines at threat depth
	• UXO:	NATO standard 7.62 round - 32cm. Larger items down to 80cm
25.	Output indicator:	Audio tone and visual LED display
26.	Pinpointing feature:	Yes
27.	Adjustment of search head angle:	Easily adjusted to cover all necessary operational situations (more than 180 degrees)

28.	Soil influence:	—
29.	Best use in:	
	• sand	Yes
	• peat	Yes
	• clay	Yes
	• ferruginous soil (laterite)	Light laterite with reduced sensitivity
30.	Optimal sweep speed:	0-2m/s
31.	Search coil/antenna:	Search coil
32.	Limitations:	—
33.	Interference (with other detectors):	None above 2m separation

Power

34.	Power supply/source:	Battery DC voltage
35.	Operating time:	Approx. 7h
36.	Power supply	
	• weight:	0.1kg
	• no. of batteries/size/type:	4 x 1.5V LR6 ANSI size AA
	• rechargeable:	Yes, but operating time is reduced to 4h

Costs

37.	Price:	
	• for one detector:	•3,000 - •4,000
	• reduction for higher quantity:	Yes
38.	System price	—
39.	Total:	—
40.	Availability for hire:	—

Others

41.	Duration of warranty:	12 months
42.	Additional equipment:	Titanium mine prodder, test piece. Carry bag available in green, camouflage or black.
43.	Additional technical data/information:	—
44.	Compliant standards:	ISO 9001, AQAP 4

Technical specifications — Stolar EDIT-3 Landmine Detector

Detector

1.	Brand:	Stolar
2.	Model:	EDIT Landmine Detector
3.	Version:	EDIT-3
4.	Used detection technology:	EDIT (electromagnetic detection and imaging transceiver)

Dimensional data

5.	Working length	
	• min. length:	18" (45.72cm)
	• max. length:	56" (142.24cm)
6.	Search head	
	• size:	7" x 6.5" x 1.5" (17.7 x 16.5 x 3.8cm)
	• weight:	2.1lb (1kg)
	• shape:	Rectangular
7.	Transport case	
	• weight:	6lb (2.7kg)
	• with equipment (full):	12lb (5.5kg)
	• dimensions:	24" x 12" x 8" (61 x 30.5 x 20cm)
	• hardcase (material):	Hard shell case
8.	Weight, hand-held unit:	4lb (1.8kg)
9.	Weight, additional equipment:	2lb (0.9kg) battery pack
10.	Other specifications:	—

Detection system specifications

11.	Control of working depth:	0" to 12"(0 to 30cm)
12.	Status:	In production since July 2004
12.	Detectors/systems in use to date:	—
14.	Other types:	—
15.	Location of use:	—

Environmental influence

16.	Humidity (limitations):	90% RH
17.	Temperature (limitations)	Virtually none
	• storage:	-4°F to +140°F (-16°C to 60°C)
	• operational:	32°F to +140°F (0°C to 160°C)
18.	Water resistant:	Yes
19.	Shock/vibration resistant:	Yes
20.	Environmental compensation:	Yes
21.	Operational hours/operating endurance	
	• low temperature (around 0°C):	—
	• medium temperature (around 20°C):	8h
	• high temperature (higher than 30°C):	—

Detection specifications

22.	Calibration/set-up:	
	• auto/manual:	Manual
	• duration:	1 minute
23.	Detection range/sensitivity details/detection performance/working depth	
	• low-metal-content mines:	100% PD for 0"-12" (0 to 30cm) depth
	• anti-vehicle mines:	100% PD for 0"-18" (0 to 45.7cm) depth
	• UXO:	PD dependent of UXO size
24.	Output indicator:	2 dimensional colour silhouette imaging (with head tracking) and audio indicators
25.	Pinpointing feature:	Head tracking cursor on screen shows position within survey grid
26.	Adjustment of search head angle:	None
27.	Soil influence:	Better performance in moist soils
28.	Best use in:	
	• sand:	—
	• peat:	Yes
	• clay:	Yes
	• ferruginous soil (laterite):	Yes

29.	Optimal sweep speed:	1 foot/s (30cm/s)
30.	Search coil:	Resonant microstrip patch antenna
31.	Limitations:	Size - low metal targets must be 2" (45.7cm)or wider in cross-sectional width (narrower if high metal content)
32.	Interference (with other detectors):	Interference with metal detectors

Power

33.	Power supply/source:	Belt-mounted battery pack
34.	Operating time:	6 to 8h depending on image processing
35.	Power supply:	
	• weight:	2lb (0.9kg)
	• no. of batteries/size/type:	2-cell lithium ion pack (5" x 4" x 3")(12.7 x 10 x 7.6cm)
	• rechargeable:	Yes
	• other:	1-cell pack (half the size, wight, and capacity)

Costs

36.	Price:	Not given
	• for one detector:	—
	• reduction for higher quantity:	—
38.	System price:	
	• with training:	—
	• spare parts:	—
	• extended warranty:	—
39.	Total:	—
40.	Availability for hire:	—

Others

41.	Duration of warranty:	12 months, extension possible
42.	Additional equipment:	—
43.	Additional technical data/information:	—
44.	Compliant standards:	ISO-9001, AQA P4

Technical specifications — Vallon VMC1

Detector

1.	Brand:	Vallon
2.	Model:	VMC1
3.	Version:	Metal mine detector
4.	Used detection technology:	Pulse induction

Dimensional data

5.	Working length	
	• min. length:	600mm (short version)
	• max. length:	1,240mm (long version)
6.	Search head	
	• size:	138 x 325mm
	• shape:	Oval
7.	Transport case	
	• weight of hard case:	Approx. 2kg
	• weight of field backpack:	Approx. 0.3kg
	• hard case with equipment (full):	Approx. 5kg
	• field backpack with equipment (full):	Approx. 2.8kg
	• dimensions hard case:	410 x 325 x 165mm
	• dimensions field backpack:	360 x 140 x 80mm
	• hard/soft case (material):	Hard case/plastic (optional accessory) Soft case/field backpack (standard accessory)
8.	Weight, hand-held unit:	Approx. 2.5kg
9.	Weight, carrying (operational detection set):	Approx. 2.5kg
10.	Weight, additional equipment:	Headset 100g
11.	Weight distribution/balance:	—
12.	Other specifications:	—

Detection system specifications

13.	Control of working depth:	Sensitivity adjustment
14.	Status:	In production
15.	Other types:	VMH3CS
16.	Location of use:	Worldwide

Environmental influence

17.	Humidity (limitations):	According to MIL STD 810F
18.	Temperature (limitations)	
	• storage:	-55°C to +75°C
	• operational:	-32°C to +60°C
19.	Water resistant:	Yes up to 1.5m
20.	Shock/vibration resistant:	Yes
21.	Environmental compensation:	Auto
22.	Operational hours/operating endurance:	Up to 8h, depending on battery type and capacity

Detection specifications

23.	Calibration/set-up	
	• auto/manual:	Automatic
	• duration:	Continual
24.	Detection range/sensitivity details/ detection performance/working depth	
	• low-metal-content mines:	Depending on their size, material and the local interference
	• anti-vehicle mines:	Depending on their size, material and the local interference
	• UXO:	Depending on their size, material and the local interference
25.	Output indicator:	Sound, visual bargraph, vibration
26.	Pinpointing feature:	Yes
27.	Adjustment of search head angle:	With a joint
28.	Soil influence:	Adjustable

29.	Best use in	
	• sand	Yes
	• peat	Yes
	• clay	Yes
	ferruginous soil (laterite)	Yes
30.	Optimal sweep speed:	0.2-1.5m/s
31.	Search coil/antenna:	Oval shape with 138 x 325mm
32.	Limitations:	No
33.	Interference (with other detectors):	Two detectors should have a distance of 1.5m between each other

Power

34.	Power supply/source:	Battery
35.	Operating time:	See point 22
36.	Power supply	
	• weight:	—
	• no. of batteries/size/type:	3 EA 1.5V standard batteries C-size
	• rechargeable:	3 EA 1.2V rechargeable battery C-size
	• other:	—

Costs

37.	Price:	
	• for one detector:	Approx. •2,300 (US$3,000) depending on optional accessories
	• reduction for higher quantity:	Yes
38.	System price:	
	• with training:	Upon request
	• spare parts:	Upon request
	• extended warranty:	Upon request
39.	Total:	
40.	Availability for hire:	Upon request

Others

41.	Duration of warranty:	24 months
42.	Additional equipment:	—
43.	Additional technical data/information:	
44.	Compliant standards:	DIN EN, ISO 9001:2000 MIL STD 810F, 501.4-II, 502.4-I, 502.4-II, 503.4, 506.4-III, 514.5 C1

Technical specifications — Vallon VMH3CS

Detector

1.	Brand:	Vallon
2.	Model:	VMH3CS
3.	Version:	Metal mine detector
4.	Used detection technology:	Pulse induction

Dimensional data

5.	Working length	
	• min. length:	920mm (short version - with oval search head) 984mm (short version - with UXO search head)
	• max. length:	1,260mm (long version - with oval search head) 1,324mm (long version - with UXO search head)
6.	Search head	
	• size:	170 x 308mm (oval search head) Diameter 615mm (UXO search head)
	• weight:	0.63kg (oval search head) 1.1kg (UXO search head)
	• shape:	Oval (oval search head) Round (UXO search head)
7.	Transport case	
	• weight:	5.2kg (with oval search head)
	• with equipment (full):	9kg (with oval search head)
	• dimensions:	515 x 435 x 198mm
	• hard/soft case (material):	Hard case/plastic (with oval seach head) Additional soft case (for UXO search head)
8.	Weight, hand-held unit:	2.7kg (with oval search head) 3.2kg (with UXO search head)
9.	Weight, carrying (operational detection set):	3.1kg
10.	Weight, additional equipment:	Headset 100g
11.	Weight distribution/balance:	—
12.	Other specifications:	—

Detection system specifications

13.	Control of working depth:	Sensitivity adjustment
14.	Status:	In production
15.	Other types:	VMM3
16.	Location of use:	Worldwide

Environmental influence

17.	Humidity (limitations):	According to MIL STD 810F
18.	Temperature (limitations)	
	• storage:	-55°C to +75°C
	• operational:	-32°C to +60°C
19.	Water resistant:	Yes up to 1.5m
20.	Shock/vibration resistant:	Yes
21.	Environmental compensation:	Auto
22.	Operational hours/operating endurance	
	• low temperature (around 0°C):	Up to 20h, depending on battery type and capacity
	• medium temperature (around 20°C):	Up to 25h, depending on battery type and capacity
	• high temperature (higher than 30°C):	Up to 25h, depending on battery type and capacity

Detection specifications

23.	Calibration/set-up	
	• auto/manual:	Automatic
	• duration:	Continual
24.	Detection range/sensitivity details/ detection performance/working depth	
	• low-metal-content mines:	Depending on their size, material and the local interference
	• anti-vehicle mines:	Depending on their size, material and the local interference
	• UXO:	Depending on their size, material and the local interference

25.	Output indicator:	Sound, visual bargraph, vibration
26.	Pinpointing feature:	Yes
27.	Adjustment of search head angle:	With a joint
28.	Soil influence:	Adjustable
29.	Best use in	
	• sand	Yes
	• peat	Yes
	• clay	Yes
	ferruginous soil (laterite)	Yes
30.	Optimal sweep speed:	0.2-1.5m/s
31.	Search coil/antenna:	Oval shape, 170 x 308mm Round shape with 615mm diameter
32.	Limitations:	No
33.	Interference (with other detectors):	Two detectors should have a distance of 1.5m between each other

Power

34.	Power supply/source:	Battery
35.	Operating time:	See point 22
36.	Power supply	
	• weight:	—
	• no. of batteries/size/type:	3 EA 1.5V standard batteries D-size
	• rechargeable:	3 EA 1.24V rechargeable battery KR35/62
	• other:	—

Costs

37.	Price:	
	• for one detector:	Between •2,400 and •4,000 (US$3,200 to US$5,200), depending on optional accessories
	• reduction for higher quantity:	Yes
38.	System price:	
	• with training:	Upon request
	• spare parts:	Upon request
	• extended warranty:	Upon request
39.	Total:	
40.	Availability for hire:	Upon request

Others

41.	Duration of warranty:	24 months
42.	Additional equipment:	UXO search head, stick probe
43.	Additional technical data/information:	
44.	Compliant standards:	DIN EN, ISO 9001:2000 MIL STD 810F, 501.4-II, 502.4-II, 503.4, 506.4-III, 514 C1

Technical specifications — Vallon VMM3

Detector

1.	Brand:	Vallon
2.	Model:	VMM3
3.	Version:	Metal mine detector
4.	Used detection technology:	Pulse induction

Dimensional data

5.	Working length	
	• min. length:	995mm (short version)
	• max. length:	1,924mm (long version)
6.	Search head	
	• size:	170 x 24 x 305mm
	• weight:	With telescopic pole 1.3kg
	• shape:	Oval
7.	Transport case	
	• weight:	5.6kg
	• with equipment (full):	11.5kg
	• dimensions:	782 x 300 x 142mm
	• hard/soft case (material):	Hard case/aluminium
8.	Weight, hand-held unit:	1.7kg
9.	Weight, carrying (operational detection set):	3.2kg
10.	Weight, additional equipment:	Headset 100g
11.	Weight distribution/balance:	—
12.	Other specifications:	—

Detection system specifications

13.	Control of working depth:	Sensitivity adjustment
14.	Status:	In production
15.	Other types:	—
16.	Location of use:	Worldwide

Environmental influence

17.	Humidity (limitations):	According to MIL STD 810F
18.	Temperature (limitations)	
	• storage:	-55°C to +75°C
	• operational:	-40°C to +60°C
19.	Water resistant:	Yes up to 1.5m
20.	Shock/vibration resistant:	Yes
21.	Environmental compensation:	Auto
22.	Operational hours/operating endurance	
	• low temperature (around 0°C):	Up to 30h depending on battery type and capacity
	• medium temperature (around 20°C):	Up to 40h depending on battery type and capacity
	• high temperature (higher than 30°C):	Up to 40h depending on battery type and capacity

Detection specifications

23.	Calibration/set-up	
	• auto/manual:	Automatic
	• duration:	Continual
24.	Detection range/sensitivity details/ detection performance/working depth	
	• low-metal-content mines:	Depending on their size, material and the local interference
	• anti-vehicle mines:	Depending on their size, material and the local interference
	• UXO:	Depending on their size, material and the local interference
25.	Output indicator:	Sound
26.	Pinpointing feature:	Yes
27.	Adjustment of search head angle:	With a joint
28.	Soil influence:	Adjustable
29.	Best use in	
	• sand	Yes
	• peat	Yes
	• clay	Yes
	• ferruginous soil (laterite)	Yes

30.	Optimal sweep speed:	0.2-1.5m/s
31.	Search coil/antenna:	Oval shape, 170 x 305mm
32.	Limitations:	No
33.	Interference (with other detectors):	Two detectors should have a distance of 1.5m between each other

Power

34.	Power supply/source:	Battery
35.	Operating time:	See point 22
36.	Power supply	
	• weight:	—
	• no. of batteries/size/type:	4 x 1.5V standard batteries D-size
	• rechargeable:	4 x 1.24V rechargeable battery KR35/62
	• other:	—

Costs

37.	Price:	
	• for one detector:	Approximately •3,000 to •6,000 depending on optional accessories
	• reduction for higher quantity:	Yes
38.	System price:	
	• with training:	Upon request
	• spare parts:	Upon request
	• extended warranty:	Upon request
39.	Total:	—
40.	Availability for hire:	Upon request

Others

41.	Duration of warranty:	24 months
42.	Additional equipment:	UXO search head, stick probe
43.	additional technical data/information:	—
44.	Compliant standards:	DIN EN ISO 9001:2000 MIL STD 810F, 501.4-II, 502.4-II, 503.4, 506.4-III, 514.5 C1

Section 2

Large-loop detectors

Ebinger UPEX® 740 M

Ebinger, Germany

Using the UPEX 740® M for battle area clearance

General description

The Ebinger Large Loop Technology **UPEX 740® M** is a valuable asset in the field of explosive ordnance clearance (EOC). It has been used for humanitarian and commercial battle area clearance operations in Afghanistan, Angola, Cambodia, France, Kosovo, Laos, the UK, and Viet Nam. Due to its size, large areas can be inspected and cleared of ammunition in a short period of time.

A new vehicle-mounted configuration has recently been developed which is applicable for route clearance/verification, area reduction or quality assurance. It can be mounted on virtually any heavy-duty vehicle and can provide an efficient and cost-effective detection system.

The system can be supplied with two different loop configurations. The number of channels can be varied between two and eight. The search process can be optimised by combining the system with a GPS for precisely locating the potential target. Colour-coded maps can be generated to facilitate the follow-on demining operation.

Main characteristics:

- The sturdy electronics unit is compact, lightweight and splash-proof;
- Target acquisition is indicated by audio alarm and by galvanometer reading;
- Detection results can be stored in a datalogger for plotting or further processing by software;
- Different indication characteristics can be selected to suit adverse working conditions;
- The equipment's audio control pulses indicate the battery condition. Audible confidence-clicks inform operators that equipment is functioning correctly;
- UPEX® is also available for underwater use or vehicle-mounted.

Working technology

UPEX® 740 M is as easy to use as a conventional mine detector. Detection signals are easy to interpret and no advanced training is required for the operators. The UPEX® detector applies the eddy current pulse induction principle for the detection of metal components in UXO. The device can be adjusted to various types of non-cooperative soils and to suppress surface-bound small fragmentation.

No further detailed technical information is given by the manufacturer.

Detectors in use to date

Since 1993, more than 500 UPEX® 740M units have been purchased. The detector is in service with various humanitarian demining organisations, the United Nations and many commercial companies.

Power supply

The UPEX® 740 M is powered by 8 x 1.5V C-cell or alternative; rechargeable battery pack 3.8A/h, 12V.

- Operational life of battery (8x1.5V alkaline 8A/h): 55 hours in position Low[1], 25 hours in position High;[1]
- Operational life of rechargeable batteries (8x1.2V 3.5A/h): 38 hours in position Low[1], 19 hours in position High.[1]

Factory support

- All detectors are covered by a 24-month warranty. The worldwide service network ensures permanent availability of spare parts;
- Operation and maintenance training is provided at Ebinger facilities or on site;
- Additional factory support by specially trained staff is provided on request;
- Instruction and maintenance manuals are available in Arabic, English, French, German, Italian, and Russian; other languages are available on request.

Maintenance and support

- There are no special requirements for the technicians or the workshop facilities. Most repairs can be carried out by Ebinger-trained staff on site;
- The step-by-step explanations in the manuals help to ensure easy maintenance of the system.

Test and evaluation

The detector went through comprehensive internal tests. Reports displaying the performance can be provided by the manufacturer on request.

Vehicle-mounted large loop detector

Reported limitations and strengths

The system has been in service for several years, but has not been tested in comparative trials. Therefore no statement regarding known limitations and strengths can be made.

1. According to the manufacturer.

Technical specifications

Ebinger UPEX® 740 M-V and UPEX® 740MM (vehicle)

Detector:

1.	Brand:	Ebinger
2.	Model:	UPEX® 740M-V and UPEX® MM (vehicle)
3.	Version:	—
4.	Used detection technology:	AEM-PI

Dimentional data:

5.	Working length:	
	• min. length:	Depending on construction on vehicle
	• max. length:	Depending on construction on vehicle
6.	Search head:	
	• size:	1,000 x 2,000 mm or multiple
	• weight:	Approx. 3kg including support frame
	• shape:	Rectangular
7.	Transport case	
	• weight:	—
	• with equipment	—
	• dimension	—
	• Hard/soft case :	—
8.	Weight, hand held unit:	—
9.	Weight, carrying(operational detection set)	—
10.	Weight, additional equipment:	—
11.	Weight distribution/balance	—
12.	Other specifications:	Alarm and reset device inside the cabin

Detection system specifications

13.	Control of working depth:	Test piece
14.	Status:	In production
15.	Detectors/systems in use to date:	50
16.	Other types:	—
17.	Location of use:	Angola, Cambodia, Eritrea, Mozambique, Sudan

Environmental influence

18.	Humidity (limitations):	None
19.	Temperature (limitations)	
	• storage	None
	• operational:	None
20.	Water resistant:	Yes
21.	Shock/vibration resistant:	Yes
22.	Environmental compensation	Manual
23.	Operational hours/operating endurance	Unlimited (car battery)

Detection specifications

24.	Calibration/setup	
	• auto / manual	Manual
25.	Detection range/sensitivity details/ detection performance/working depth	
	• low-metal-contents mines:	Not suitable
	• anti-vehicle mines:	Designed for
	• UXO:	Designed for
26.	Output indicator:	Acoustical, optical, analogic output for data recording
27.	Pinpointing feature:	Yes
28.	Adjustment of search head angle:	Not necessary
29.	Soil influence:	Adjustable
30.	Best use in	
	• sand	Yes
	• peat	Yes
	• clay	Yes
	• ferruginous soil (laterite)	Limited

31.	Optimal sweep speed:	8-10km/h
32.	Search coil/antenna:	Rectangular
33.	Limitations:	—
34.	Interference (with other detectors):	12m

Power

35.	Power supply/source:	Car battery
36.	Operation time:	Unlimited
37.	Power supply:	
	• weight:	—
	• no of batteries:	—
	• other:	System supplied with power cables

Costs

38.	Price:	
	• for one detector:	More than US$5,000
	• reduction for higher quantity:	Yes
39.	System price	
	• with training:	Included
	• spare parts:	Included
	• extended warranty:	On request
40.	Total:	—
41.	Availability for hire:	Yes

Other

42.	Duration of warranty	24 months
43.	Additional equipment:	Support frame for vehicle on request
44	Additional technical data/information:	Available on request
46.	Compliant standards:	MIL-STD

Section 3

UXO detectors

Ebinger MAGNEX 120 LW

Ebinger, Germany

Schematic diagram of Ebinger MAGNEX 120 LW

Detector in operation

General description

MAGNEX® 120 LW has been developed for accurate bomb disposal, and in particular for the detection of ferromagnetic ammunition located in the ground or in shallow water. The locator is designed for borehole use to indicate deeply buried UXO, or for operation in areas with substantial interference from surface fragments.

The pinpoint location with audio signal and the digital multi-channel system ensure a high level of reliability and user-friendliness.

Working methodology

MAGNEX® 120 LW works on the gradiometer principle, which detects geomagnetic field interference. Objects made from ferromagnetic material can show a magnetic field which superimposes on the natural terrestrial field. Amplitude and polarity of the local anomaly are used to indicate the position of the UXO.

Digital measurement data logging:
To ease data collection and storage the MAGNEX® locators and the MAGNETO® system suit each other perfectly and increase productivity in bomb disposal substantially. A high degree of field input makes the system very user-friendly. Its functionality facilitates its use when investigating the extent of pollution or when processing detection data from ammunition. In conjunction with the DLM datalogger the system can be used as a man-portable single-channel or triple-channel system.

The detector is equipped with a new Ebinger-developed inductor system which ensures a base clearance of 430mm.

Ease of operation and a rigid mechanical design facilitate reliable operation for professional clearing tasks. The stepping switch offers the following sensitivity ranges:

Level 1: 3,000 nT/m;
Level 2:1,000 nT/m;
Level 3: 300 nT/m;
Level 4: 100 nT/m;
Level 5: 30 nT/m;
Level 6: 10 nT/m.

No further detailed information is given by the manufacturer.

Detectors in use to date

Since 1993, more than 1,200 units of MAGNEX® 120 have been purchased. The detector is in service with various NGOs and commercial companies worldwide.

Power supply

- The MAGNEX® 120 LW is powered by 6 x 1.5V round cell LR20;
- Operational life of battery: approximately 40 hours.[1]

Factory support

- All detectors are covered by a 24-month warranty. The worldwide service network ensures permanent availability of spare parts;
- Operation and maintenance training is provided at Ebinger facilities or on site;
- Additional factory support by specially trained staff is provided on request;
- Instruction and maintenance manuals are is available in Arabic, English, French, German, Italian, and Russian; other languages are available on request.

Maintenance and support

- There are no special requirements for the technicians or the workshop facilities. Most repairs can be carried out by Ebinger-trained staff on site;
- The step-by-step explanations in the manuals ensure easy maintenance of the system.

Test and evaluation

The detector went through comprehensive internal tests. Reports displaying the performance can be provided by the manufacturer on request.

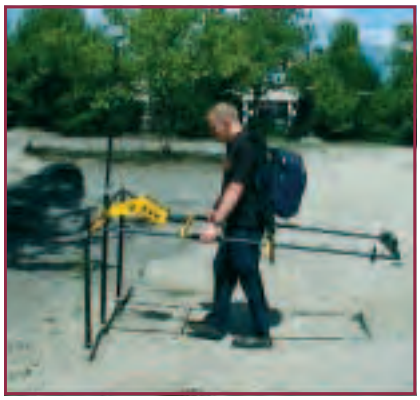
Reported limitations and strengths

No information available at this time.

1. According to the manufacturer.

Foerster FEREX 4.032

Institut Dr. Foerster, Germany



FEREX 4.032 DLG with 3-probe holder

FEREX 4.032 DLG and FEREX DATALINE in dialogue

General description

The **FEREX 4.032** is a metal detector using the fluxgate magnetometer principle to detect magnetic anomalies caused by ferromagnetic objects. Its primary use is to search for UXO to depths of approximately 8m.[1] Under certain circumstances (for example, anti-vehicle mines covered by up to 2m of desert sand) the FEREX can successfully be used for mine detection.

The detector replaces the FEREX 4.021, which was introduced on the market in the mid-1990s.

Due to the tension band technology inside the Foerster magnetometer, the system is known as one of the most sensitive fluxgate magnetometers available. These probes are lifetime-calibrated — even if used within a rough environment or within an extreme climate. The standard hand-held version "FEREX 4.032 API" indicates ferromagnetic objects by a pointer instrument and sound.

Due to the modular character of the system a simple exchange of the control box upgrades the unit to a FEREX 4.032 DLG (datalogger). This detector combines the API features with an integrated four channel datalogger for scanning fields in order to evaluate the resulting map of magnetic anomalies on a standard PC. The software FEREX Dataline calculates, among other data, the exact position, depth or orientation of the scanned objects.

FOERSTER MULTI CAT with DATAMONITOR in operation

The system is capable of fulfilling tasks such as underwater or borehole search.

The high end solution within this instrument family is a vehicle-based multichannel system (Foerster Multicat), supported by a differential Global Positioning System (GPS).

Following customer feedback, in 2002 the FEREX 4.032 was modified in order to minimise its length. Some smaller mechanical modifications have been undertaken to optimise the handling. At the same time the Evaluation Software Dataline was equipped with a bundle of optional features. New types of multi-probe-holder have been introduced.

FOERSTER supplies FEREX in three different versions: the FEREX API with a classic pointer instrument, and the datalogger versions: FEREX DLG STD and FEREX DLG GPS Cartograph. The FEREX DLG GPS Cartograph is designed for connection to all conventional GPS with RTK(Real Time Kinematic) operational mode and laser positioning systems (Tachymeter Total Station).

Working methodology

By detecting variations within the earth's magnetic field, the FEREX indicates plus and minus poles of ferromagnetic objects. Geometry and strength of the detected poles enable the user to determine the location, depth and size of the object. In general, problematic soil types do not influence the results gained from this working principle as known from EMI detectors.

Power supply

As standard, the FEREX 4.032 gets powered by four 1.5V D cells. Rechargeable batteries can be used, the indicated operating times varying depending on their quality and age. Sensitivity and detection quality are never influenced by battery condition. Operating time with one set of alkaline batteries reaches 60 hours (in intermittent operation) or 36 hours (datalogger).

FEREX 4.032 DLG connected to GPS in operation

Detectors in use to date

The FEREX 4.032 has been in service since early 2000 and has been used in the following countries: Afghanistan, Australia, Austria, Bulgaria, Canada, Croatia, Denmark, Egypt, Finland, France, Germany, Indonesia, Iran, Ireland, Italy, Japan, the Netherlands, Portugal, Poland, Russia, Spain, Tunisia, UK, Uruguay, the US, and Viet Nam.

Factory support

Spare parts are available exclusively from Foerster. Standard rechargeable batteries can be purchased on the free market.

In addition to direct support from Foerster in Germany, the company provides a worldwide net of representatives in more than 40 countries. Most offer complete after-sales service. Besides offering training on the customer's site, Foerster provides modern test and training facilities in Reutlingen, Germany. A full training programme for trainers, including lessons on background knowledge and using a variety of training materials, is available in English and German. On request, training forms part of a purchasing package. Standard manuals and service documentation are available in English, French, German and Spanish. Other languages are available on request.

Maintenance and support

- The FEREX maintenance system is organised on two levels: Level one - Basic field maintenance; Level two - Workshop maintenance.
- The recommended number of workshops depends on the logistic set-up. The personnel for handling a workshop must have basic knowledge of mechanical and electronic repairs.
- Foerster offers supply of complete tool sets and testing equipment as well as service training. Fully equipped workshops with trained personnel are able to handle all repairs down to the factories final assembly.

Test and evaluation

Foerster performs tests within its own facilities mainly for research and quality control. The manufacturer states that tests are largely carried out under "real" conditions.

Reported limitations and strengths

No information is available at this time.

1. According to the manufacturer.

GEOMETRICS G-858

Geometrics, US

G-858 with ag 132 DGPS System

General description

Geometrics designs and manufactures high-sensitivity total field magnetometers for locating ferrous objects beneath the ground. The primary tool for this application is the G-858 Cesium Vapor MagMapper system. The G-858 can be configured with one or two sensors, allowing for gradient measurements as well as logging of GPS for positioning. The system samples at ten times per second at noise levels of about 0.05nT thus providing extremely rapid survey of large areas of land, up to 2 acres (1 hectare) per hour. Designed in 1996, Geometrics has supplied this equipment to Naval Research Labs, the Army Corps of Engineers, UXB, Parsons and most other large-scale UXO detection companies and institutes.

Working methodology

The basic operating priciple of the optically pumped cesium vapour magnetometer is described in a paper *(Cesium Magnetometer Theory)* available from the company's website (*www.geometrics.com*). Basically it is an atomic clock which oscillates at a frequency dependent on the ambient magnetic field. It is a passive device, measuring distortion in the earth's magnetic field, thus allowing much greater range than that typically associated with metal detectors. The rule of thumb is that 250lb (110kg) of iron or steel can be detected at 50ft (15m); 30lb (13kg) at 25 ft (7m); and 4lbs (2kg) at 12ft (4m). Output is visual and audio. The most powerful feature is its mapping ability, which can detect small ferrous objects or deeper objects not detectable with metal detectors or in search mode. This is especially useful in initial reconnaissance and certifying site clearance. The magnetometer only senses ferrous material (containing iron or steel) and thus soil conditions, types, presence of water, etc., do not impact performance. However, the magnetometer cannot detect the presence of gold, aluminum, brass or plastic. It is sensitive to excavation where normal soil magnetization has been disturbed.

Detectors in use

There are some 330 G-858 systems operational worldwide. The company estimates that approximately one third of those are used for UXO detection, the remainder being employed for mining/oil/gas survey, environmental assessment, utility location, forensics and archeology.

Power supply

Battery is rechargeable lead acid gel cell, 24V, giving 6 hours of use per charge for gradiometer, 8 hours for single sensor operation. The battery is worn as a belt.

Factory support

Spares are available from Geometrics factory in San Jose, California, and limited spares can be obtained in the UK. The manufacturer offers factory training at its facility in Silicon Valley or at the customer's site. Training is not included in the purchase price but quoted separately. The detector is available for hire.

Maintenance support

According to the manufacturer no maintenance is required on the G-858 other than cleaning of connectors. The company recommends two operators per system to maximise productivity and to assist in positioning of survey lines.

Test and evaluation

Internal test reports can be provided by the manufacturer.

G-858 in operation

Cart-mounted G-858

Reported limitations and strengths

The magnetometer does not perform well in highly magnetic volcanic soils such as those encountered in the Hawaiian island chain (Kaho'olawe). This is due to the presence of large amounts of magnetic rock in the near vacinity of the detector, masking buried object signatures.

Geonics EM 61-Mk2

Geonics Ltd., Canada

EM 61-Mk2

General description

The **EM 61-Mk2 Metal Detector** is a high-power, high-sensitivity metal detector suitable for applications in the detection of both ferrous and non-ferrous metal.

Each system includes a coincident transmitter/receiver coil (1 x 0.5m); a second receiver coil (1 x 0.5m); backpack-mounted system electronics and power supply; and a GPS-compatible data acquisition system with supporting software.

Since the introduction of the original EM 61 Metal Detector in 1994, advances in design and application have provided greater functionality and enhanced detection capabilities within a wider range of operating environments. In addition to the current EM 61-Mk2 model, several modifications and variations are available to address specific targets and/or operating conditions. Options include a hand-held coil system for increased lateral target resolution; a submersible coil for use in both fresh and salt water environments; and a high power modification to increase detection limits associated with all targets.

For a substantial increase in productivity, particularly over larger survey areas, multiple systems can be configured as a single array to be towed behind a vehicle.

The EM 61 series of metal detectors is recognised within the North American defense community as a standard application technology for the detection of UXO. Complementary applications include the delineation of environmental hazards, utilities and infrastructure at both active and inactive military installations.[1]

Working methodology

Operating on the principles of time domain electromagnetics (TDEM), the EM 61-MK2 generates a primary magnetic field that induces electrical eddy currents in nearby metallic objects. The receiver coils measure the strength of secondary magnetic fields associated with the induced eddy current flow.

The standard EM61-MK2 will detect metallic objects to a depth of 5m maximum. The maximum depth at which any individual object can be detected is determined uniquely by its size, composition and orientation. Increased detection depths for all objects can be achieved with a high-power modification to the system.

The EM 61-MK2 provides both audio and visual anomaly indicators. The visual indicator can be presented in both graphical and text formats.

Designed to be relatively insensitive to the soil/water matrix, the EM 61-Mk2 can be operated in most environments without geologic interference. A simple nulling procedure establishes the zero reference level at each site.

Detectors in use

Since the introduction of the original EM 61 in 1994, total sales have exceeded 300 units worldwide. Customer groups are varied and include consultants to the environmental/engineering/defense industries, military agencies, government research institutes and universities.

For applications in ordnance detection specifically, operations have been concentrated geographically within Canada and the US, primarily at military installations (e.g. Fort Ord, California; Fort Hood, Texas) and unpopulated target ranges.

Outside of North America, the EM 61 series has been applied to ordnance detection in several countries, including Australia, Germany, Poland, Spain, and the UK.

EM 61-HH Mk2 (modification of EM 61-Mk2)

Power supply

Power is supplied from a self-contained, rechargeable 12V gel cell battery mounted on an operator-carried backpack. Two batteries with chargers are supplied with each system. Average battery life during continuous operation is 4 hours; optional high power batteries are available for extended applications.

Factory support

- Technical support is provided by Geonics Ltd. directly. Assistance is also available from an extensive network of representatives worldwide;
- An inventory of spare parts is maintained at the factory. The standard warranty provides coverage of coils and cables for six months, and one year on all other components;
- Introductory (half-day) training at the factory is included with purchase. Extended training, at the factory or on site, is also available; additional cost is associated with any extended training programme;
- Technical notes, case studies and instruction manuals included with purchase are available in English; limited documentation in other languages can be made available upon request.

Maintenance and support

- The EM 61-Mk2 does not require general maintenance. The system should be stored dry and clean with the batteries fully charged;
- The EM 61-Mk2 requires a single operator only;
- Repair/service generally requires either simple component replacement or return to the factory;
- Comprehensive on-site service by operator/technician requires training.

Test and evaluation

Several models of the EM 61 series have been tested and evaluated through government-sponsored projects for applications in the detection of UXO. Reports associated with such tests are published and available for distribution upon request.[2,3]

Applications in landmine detection have received only limited consideration. Preliminary indications suggest that the EM 61-Mk2 would be sensitive to larger (e.g. anti-vehicle) targets only.

Reported limitations and strengths[1]

Specific applications can be limited by available coil configurations — e.g. the standard configuration can be difficult to operate in vegetative overgrowth. Modified operating procedures or application-specific configurations can address most limitations.

Soils with a very high magnetic susceptibility response can present noise in the data. A recently patented technique should reduce the effect of such noise.

As the detector has not been tested in comparative trials there is no further detailed information available.

1. According to the manufacturer.
2. M. Fernandez, A. Lewis, F. Littmann, *PROM 1 Anti-personnel landmines - Probability of activation by physical contact with a metal detector*, Special publication No. I.01.29, European Commission Directorate General JRC Joint Research Centre Institute for Systems, Informatics & Safety, Ispra, March 2001, Annex A, p. 100.
3. Y. Das, J.T. Dean, D. Lewis, J.H.J. Roosenboom, G. Zahaczewsky (eds), *A multi-national technical evaluation of performances of commercial off the shelf metal detectors in the context of humanitarian demining*, International Pilot Project for Technology Co-operation, Final report, European Commission, Joint Research Centre, Ispra, Italy, 2001, Annex A, p. 101.

T&A 3D Borehole Radar

T&A Survey, the Netherlands

Radar unit

General description

The **3D Borehole Radar** (BHR) system is a geophysical technique for high-resolution 3D mapping of the surroundings of a borehole. This technique, applied in a single borehole, combines all the advantages of ground-penetrating-radar tools in one piece of equipment: high-resolution data with directional information up to 1 degree accuracy in angular direction and with a penetration range up to 15m. This is a particularly promising technology as it allows UXO survey to greater depths with very high accuracy and in difficult circumstances.

The 3D Borehole Radar consists of four main parts:

- positioning unit,
- radar unit,
- cable (power supply and data transmission), and
- operating and processing software.

The whole 3D BHR system is pulled or pushed through a non-metallic cased and water-filled borehole. It was developed by T&A Survey in cooperation with TNO-FEL, the National Air and Space Travel laboratory and the Dutch Department of Defence. The technology is patented.

Working methodology

The 3D BoreHole Radar system transmits electromagnetic waves with a centre frequency of around 100MHz. During measurements radar waves are emitted into the subsurface by means of a transmitter antenna, situated in the borehole. When the transmitted wave meets a contrast in material parameters (caused by an object or geological boundary), part of the wave is reflected and received by the receiver antenna, situated in the same borehole. The remaining part of the wave travels further away from the borehole and reflects on the next material boundary. By rotating the antenna system and moving the 3D Borehole Radar system vertically in the borehole a continuous 3D image of the subsurface is obtained. The travel time of the radar wave between the moment of sending, reflecting and receiving is measured. When information about the speed of the radar waves in the subsurface is available, the travel times can be converted to determine the distance and direction of the reflector.

The detection range of the 3D BHR is 5–15m in every direction, depending on the soil type. The resolution is high (objects of 100mm size can be detected at 5m).

Detectors in use

At the moment there is one field system in use; an industrial series is in progress.

Power supply

The 3D Borehole Radar relies on an external power supply of 230V AC/50Hz (at least 3kW). The power consumption is 60W on average.

Factory support

The 3D Borehole radar is covered by a 12-month-warranty. A worldwide service network ensures quick availability of spare parts.

Operation and maintenance training is provided at our facilities or on site.

Instruction and maintenance manuals are available in English.

Maintenance support

The 3D Borehole Radar requires a crew of two operators.

Test and evaluation

The 3D Borehole Radar has gone through an extensive testing programme for UXO detection. Test reports are available on request.

3D Borehole Radar in operation

Reported limitations and strengths

The 3D Borehole works best in sandy soils and non-conductive (fresh) water.

Due to a lack of independent test reports no further information can be provided.

Vallon EL 1302D1

Vallon, Germany

VXV4 sensor platform

Vallon EL 1302D1 with GPS

General description

The Vallon **EL1302D1** ferrous locator is a highly sensitive difference magnetometer used for the detection of bombs, shells, mortar projectiles and other UXO. It indicates any disturbance caused in the earth's magnetic field by buried ferrous objects, providing indications to the operator both acoustically and visually. This equipment is used for land-based detection and the locators have an interface for the Vallon field computer VFC1.

The EL 1302D1 is designed for all-weather use, using glass fibre and carbon fibre materials to reduce the weight of the locator.

The EL 1302D1 is equipped with a digital signal output for direct connection of the Vallon memo box MB4, the Vallon field computer VFC1 and for direct data recording in conjunction with a commercial laptop computer running the VALLON EVA2000å software. To relate the exact x-y coordinates to the measuring data, the Vallon sensor positioning system (SEPOS®) or a global positioning system (GPS) receiver with antenna and a GPS reference station receiver can be connected.

Operation is simple, with only a short training period required before operation.

The VFC1 field computer (carried on the locator) displays in real time the measured nano-Tesla (nT) values as a curve. In addition, the GPS position is displayed (corrected once every second), along with an integrated GPS window that guides the operator using simple symbols for the walking direction and starting and stopping positions. The operator is thus guided by the VFC1.

After a survey, the recorded data from the VFC1 is downloaded to a laptop or PC running the VALLON EVA2000å software. The operator can then evaluate any suspected ferrous unexploded ordnance targets. A complete target list and true to scale map can be printed out for follow-up operations. Both the lists and maps indicate the field and each target by its GPS position in latitude and longitude.

A maximum of four detectors can be arranged on the Vallon VXV4 sensor platform for the detection of UXO over large areas. The vehicle incorporates the array of ferrous locators operating with the Vallon field computer VFC1 as datalogger and GPS.

The detector complies with environmental conditions according to MIL STD 810E 501.3, 502.3, 503.3, 506.3, 514.4

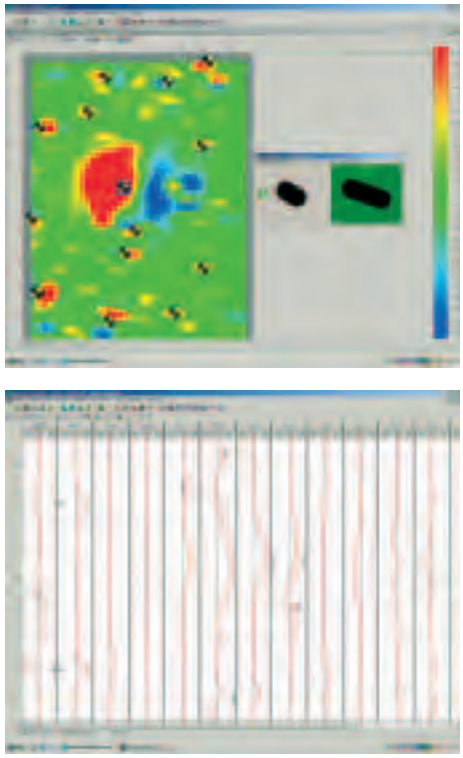
Main components

1. Electronics unit with battery compartment.
2. Sensor part with carrying bar and control unit.
3. Non-magnetic headset.
4. Carrying belt.
5. Set of adjusting tools.
6. One set (6 EA) round cells 1.5V IEC R 14 alkaline C-size, 7.8A/h each.
7. Operation manual.
8. Aluminium shipping and storage case.

Working methodology

The Vallon differential magnetometers work on the principle of measuring the distortion of the earth's magnetic field. Two magnet sensors are vertically mounted in a tube at 50cm (model VET1: 170cm) distance to measure the earth's magnetic field. Both values are subtracted and result in zero. A ferromagnetic target is disturbing the homogenous field and result in two different values so that the difference is not zero. Depending on the signal amplitude and polarity the alarm signal is computed.

Software VALLON EVA 2000 (evaluation and analysis software) installed for realtime display of measuring the graph, storage and evaluation directly on site.



Results provided by EVA 2000.

Detectors in use

The locators are in service with many commercial EOD organisations, several NATO partners and other armed forces.

Power supply

EL1302D1 is powered by six 1.5V round cells IECR14 alkaline or rechargeable 1.2V Ni-MH-Batteries RSH 1.8. The operational life of batteries is said to be approximately 20 hours with alkaline batteries without datalogger, depending on the age, quality and capacity of the batteries.

Factory support

Vallon runs a worldwide servicing network with all current spare parts in stock. Spare parts can be delivered with the relevant maintenance manual directly to the customer for on-site repair.

Operation and maintenance training in offered either in the Vallon facilities or at a location required by the customer.

The operation manuals and the maintenance manuals are available in English and German, and other languages on request.

Warranty 24 months.

Maintenance support

There are no special requirements for the technicians or the workshop facilities. All tools are standard and available in most of the workshops. For each detector a maintenance manual is available, with step-by-step explanation for the repair of the detector.

Test and evaluation

The manufacturer allows access to several available test reports.

Reported limitations and strengths

Detection of ferrous targets only. No additional information available at this time.

Technical specifications — Ebinger MAGNEX® 120 LW

Detector:

1.	Brand:	Ebinger
2.	Model:	MAGNEX® 120 LW Magnetometer
3.	Version:	05/2001
4.	Used detection technology:	Difference magnometer using fluxgate principle

Dimensional data:

5.	Working length:	
	• length:	1,280mm complete
	• probe:	600mm
6.	Search head:	
	• size:	600 x 43mm
	• weight:	1.5kg
	• shape:	Cylinder probe
7.	Transport case:	
	• weight:	3kg
	• with equipment	4.2kg/11kg
	• dimension	880 x 280 x 180mm
	• hard/soft case (material)	Hard plastic / canvas satchel
8.	Weight, hand held unit:	1.2kg
9.	Weight, carrying(operational detection set):	4.2kg
10.	Weight, additional equipment:	—
11.	Weight distribution/balance:	—
12.	Other specifications:	—

Detection system specifications

13.	Control of working depth:	Sensitivity adjustment manual/auto
14.	Status:	In production
15.	Detectors/systems in use to date:	More than 1,200
16.	Other types:	—
17.	Location of use:	Worldwide

Environmental influence

18.	Humidity (limitations):	0-95%
19.	Temperature (limitations)	
	• storage	-53°C to +70°C
	• operational:	-30°C to +55°C
20.	Water resistant:	Yes
21.	Shock/vibration resistant:	Yes
22.	Environmental compensation:	Auto / manual
23.	Operational hours/operating endurance	
	• low temperature (around 0°C):	Up to 75h, depends on type of battery
	• medium temperature (around +20°C):	Up to 75h, depends on type of battery
	• high temperature (around +30°C):	Up to 75h, depends on type of battery

Detection specifications

24.	Calibration/setup	
	• auto / manual	Manual - automatic
	• duration	Continual
25.	Detection range/sensitivity details/ detection performance/working depth	
	• low-metal-content mines:	—
	• anti-vehicle mines:	Depending on their size, material and the local interference
	• UXO:	Depending on their size, material and the local interference
26.	Output indicator:	Optical, sound and data output
27.	Pinpointing feature:	Yes
28.	Adjustment of search head angle:	Yes
29.	Soil influence:	—

30.	Best use in	
	• sand	Yes
	• peat	Yes
	• clay	Yes
	• ferruginous soil (laterite)	Yes
31.	Optimal sweep speed:	0.2-1.5m/s
32.	Search coil / antenna:	Probe 600mm
33.	Limitations:	Only ferromagnetic material
34.	Interference (with other detectors):	< safety distance

Power

35.	Power supply/source	Battery
36.	Operation time:	See point 23
37.	Power supply:	
	• weight:	—
	• no of batteries:	6 x 1.5V dry batteries LR-20
	• rechargeable:	7 x 1.2V rechargeable batteries
	• other:	—

Costs

38.	Price:	
	• for one detector:	US$4,000-US$5,000
	• reduction for higher quantity:	Yes
39.	System price	
	• with training:	On request
	• spare parts:	On request
	• extended warranty:	On request
40.	Total:	—
41.	Availability for hire:	On request

Other

42.	Duration of warranty	24 months
43.	Additional equipment:	Borehole cable
44	Additional technical data/information:	—
46.	Compliant standards:	EMC tests according to MIL-STD 461 D, DIN EN ISO 9001:2000

Technical specifications — Foerster FEREX 4.032

Detector

1.	Brand:	Foerster
2.	Model:	FEREX 4.032
3.	Version:	API, DLG, DLG Kartograph
4.	Used detection technology:	Metal detector working by fluxgate magnetometers

Dimensional data

5.	Working length:	Approx. 1.4m
6.	Search sensor:	
	• size:	Length 853-1,800mm /diameter 35mm
	• weight:	0.55-1kg
	• shape:	Tube
7.	Transport case:	
	• weight:	Approx. 4kg
	• with equipment (full):	Approx. 9kg
	• dimensions:	995 x 265 x 335mm
	• hard/soft case (material):	Hardcase/plastics
8.	Weight, hand-held unit:	Approx. 4kg
9.	Weight, carrying (operational detection set):	Approx. 4kg
10.	Weight, additional equipment:	Headphones 0.1kg
11.	Weight distribution/balance:	Balanced around the handgrip
12.	Other specifications:	——

Detection system specifications

13.	Status	In production
14.	Detectors/systems in use to date:	—
15.	Other types:	—
16.	Location of use:	—

Environmental influence

17.	Humidity (limitations):	No limitations
18.	Temperature (limitations)	
	• storage:	-57°C to + 70°C
	• operational:	-35°C to + 70°C
19.	Water resistant:	Sensor is 100m sea-waterproof. Electronics unit is highly splash-proof. See MIL-STD specs.
20.	Shock/vibration resistant:	See MIL-STD specs.
21.	Environmental compensation:	6 operation modes for suppression of electromagnetic influences and filter for big/small objects.
22.	Operational hours/operating endurance	
	• medium temperature (around 20°C):	Depending on working rhythm and instrument type : approx. 35-80h with alkaline batteries.

Detection specifications

23.	Detection range/sensitivity details/ detection performance/working depth	
	• low-metal-content mines:	No
	• anti-vehicle mines:	Full metal case (ferromagnetic) approx. 2m
	• UXO:	Hand grenade: approx. 50cm; 500lbs bomb (Mk 82): 4-6m max.; 1,000lb bomb: 5-8m. max.
24.	Output indicator:	Audio by inbuilt speaker or headphones, visible by pointer instrument and on screen via evaluation software Dataline
25.	Adjustment of search head angle:	Manual
26.	Best use in	
	• sand	Yes
	• peat	Yes
	• clay	Yes
	• ferruginous soil (laterite)	Yes
27.	Interference (with other detectors):	No

Power

28.	Power supply/source:	4 x 1.5V mono-cell IECLR (ANSI standard size D)
29.	Operating time:	35-80h with alkaline batteries
30.	Power supply	
	• weight:	Not applicable since forming part of the unit
	• no of batteries/size/type:	4 x 1.5V mono-cell IECLR (ANSI standard size D)
	• rechargeable:	Possible
	• other:	Not applicable

Costs

31.	Price:	
	• for one detector:	More than US$5,000
	• reduction for higher quantity:	Yes
32.	System price	
	• with training:	Depending on quantity
	• spare parts:	Depending on quantity
	• extended warranty:	Available on request
33.	Total:	t.b.d.
34.	Availability for hire:	Available

Other

35.	Duration of warranty:	24 months
36.	Additional equipment:	Headphones, workshop equipment and tools, GPS, multi-probe-holders (hand-held and vehicle-based), underwater cables, borehole equipment
37.	Additional technical data/information:	Service manuals, training programme
46.	Compliant standards:	Military standards MIL-STD 810E 514.4-1 Vibration MIL-STD 810E 516.4 Mechanical shock, Procedure I MIL-STD 810E 516.4 Drop test, Procedure IV MIL-STD 810E 501.3 High temperatures MIL-STD 810E 502.3 Low temperatures MIL-STD 810E 506.3-1 Rain MIL-STD 810E 503.3 Temperature shock (transport) MIL-STD 810E 512.2 Leak test MIL-STD 810E 505.3 Solar radiation (sunshine), Procedure I MIL-STD 461DRE 102 5.3.13.1 Radiation MIL-STD 461DRS 103 Irradiation EMC according to MIL-STD 461D

Technical specifications — Geometrics G-858

Detector

1.	Brand:	Geometrics
2.	Model:	G-858
3.	Version:	Single or gradiometre
4.	Used detection technology:	Optically pumped cesium vapour total field magnometre

Dimensional data

5.	Working length	
	• min. length:	4ft (1.22m)
	• max. length:	5ft (1.52m)
6.	Search head	
	• size:	2.5" x 6" (6.35 x 15.24cm)
	• weight:	0.5lb (0.22kg)
	• shape:	Cylinder
7.	Transport case:	
	• weight	25lb (11.4kg)
	• with equipment (full):	70lb (31.7kg)
	• dimensions:	10 x 14 x 30" (25.4 x 35.5 x 76.2cm)
	• hard/soft case (material):	Rotomolded hard case
8.	Weight, hand-held unit:	Wand: 4lb (1.8kg)
9.	Weight, carrying (operational detection set):	Complete mag 25lb (11.4kg)
10.	Weight, additional equipment:	GPS backpack 10lb (4.5kg)
11.	Other specifications:	—

Detection system specifications

12.	Control of working depth:	Inverse cube rule, 4lb 12 feet (1.8kg 3.65m)
13.	Status (development/in production):	In production
14.	Detectors/systems in use to date:	350 delivered since 1996
15.	Other types:	Gradiometer (2 sensors), mounted on car or aircraft
16.	Location of use:	Worldwide

Environmental influence

17.	Humidity (limitations):	95% non-condensing
18.	Temperature (limitations)	
	• storage:	-20°C to +70°C
	• operational:	-10°C to +50°C
19.	Water resistant:	Yes
20.	Shock/vibration resistant:	Yes
21.	Environmental compensation:	Not applicable
22.	Operational hours/operating endurance:	
	• low temperature (around 0°C):	5h
	• medium temperature (around 20°C):	6h
	• high temperature (higher than 30°C):	6h

Detection specifications

23.	Calibration/setup	Not applicable
24.	Detection range/sensitivity details/ detection performance/working depth	
	• low-metal-content mines:	1lb (0.5kg) ferrous material 6 ft (2m)
	• anti-vehicle mines:	2lb (0.9kg) ferrous material at 8ft (2.5m)
	• UXO:	Complete list available
25.	Output indicator:	Audio, visual and mapping
26.	Pinpointing feature:	—
27.	Adjustment of search head angle:	Not applicable, omnidirectional
28.	Soil influence:	Volcanic soil interference probable
29.	Best use in:	
	• sand	Yes
	• peat	Yes

	• clay	Yes
	• ferruginous soil (laterite)	Yes
30.	Optimal sweep speed:	Full walking speed
31.	Search coil/antenna:	Cesium mag sensor
32.	Limitations:	Nearby large steel structures, cars/vehicles within 15ft (4.5m)
33.	Interference (with other detectors):	Interference from EM 61 Geonics time domain EM system, roughly 100ft (30m)

Power

34.	Power supply/source:	24V rechargeable battery pack
35.	Operating time:	6-8h per charge, 2 batteries supplied per system
36.	Power supply	
	• weight:	10lb (4.5kg)
	• no of batteries/size/type:	Gel cell 4 x 6V
	• rechargeable:	Yes
	• other:	—

Costs

37.	Price:	
	• for one detector:	More than US$5,000
	• reduction for higher quantity:	Quantity discount available
38.	System price	
	• with training:	Training separate
	• spare parts:	Contact factory
	• extended warranty:	Available, 3% per year
39.	Total:	—
40.	Availability for hire:	Yes

Others

41.	Duration of warranty:	12 months
42.	Additional equipment:	GPS, steering, analysis software capabilities
43.	Additional technical data/information:	Available at *www.geometrics.com*
44.	Compliant standards:	Sensor designed under military spec.

Technical specifications — Geonics EM 61 HH - Mk2

Detector

1.	Brand:	Geonics Limited
2.	Model:	EM 61HH – Mk2
3.	Version:	—
4.	Used detection technology:	Time domain electromagnetic induction

Dimensional data

5.	Working length	
	• min. length:	1m
	• max. length:	1.5m
6.	Search head	
	• size:	33 x 20cm
	• weight:	2.8kg
	• shape:	Elliptical
7.	Transport case:	
	• weight	—
	• with equipment (full):	50kg
	• dimensions:	117 x 50 x 54cm
	• hard/soft case (material):	Hard, plywood, aluminium laminated
8.	Weight, hand-held unit:	—
9.	Weight, carrying (operational detection set):	4kg
10.	Weight, additional equipment:	7.5kg with optional wheels
11.	Weight distribution/balance:	—
12.	Other specifications:	—

Detection system specifications

13.	Status (development/in production):	In production
14.	Detectors/systems in use to date:	50
15.	Other types:	5 (production)
16.	Location of use:	Worldwide

Environmental influence

17.	Humidity (limitations):	100%
18.	Temperature (limitations)	
	• storage:	-40°c to +50°c
	• operational:	-30°c to +50°c
19.	Water resistant:	Yes
20.	Shock/vibration resistant:	Yes
21.	Environmental compensation:	Auto
22.	Operational hours/operating endurance:	4h per battery
	• low temperature (around 0°C):	3.5h
	• medium temperature (around 20°C):	4h
	• high temperature (higher than 30°C):	4h

Detection specifications

23.	Calibration/setup	
	• auto/manual:	Auto
	• duration:	10s
24.	Detection range/sensitivity details/ detection performance/working depth	
	• low-metal-content mines:	No
	• anti-vehicle mines:	Yes
	• UXO:	20mm cartridge to 0.7m, 103mm projectile to 1.3m
25.	Output indicator:	Sound, graphic display
26.	Pinpointing feature:	Yes
27.	Adjustment of search head angle:	Yes
28.	Soil influence:	Extreme magnetic susceptibility

29.	Best use in:	
	• sand	Yes
	• peat	Yes
	• clay	Yes
	• ferruginous soil (laterite)	Yes
30.	Optimal sweep speed:	1m/s
31.	Search coil/antenna:	—
32.	Limitations:	—
33.	Interference (with other detectors):	Variable, depending on detector type

Power

34.	Power supply/source:	12V rechargeable gel cell battery
35.	Operating time:	4h
36.	Power supply	
	• weight:	4.5kg
	• no of batteries/size/type:	1
	• rechargeable:	Yes
	• other:	Optional high power battery

Costs

37.	Price:	
	• for one detector:	More than US$5,000
	• reduction for higher quantity:	—
38.	System price	
	• with training:	Additional US$600 per day
	• spare parts:	Available upon request
	• extended warranty:	N/A
39.	Total:	US$19,375
40.	Availability for hire:	Yes

Others

41.	Duration of warranty:	6 months on coils, cables and batteries; 12 months on other components
42.	Additional equipment:	Includes hand-held PC for data storage and GPS capabilities
43.	Additional technical data/information:	—
44.	Compliant standards:	Hazards of electromagnetic radiation on ordnance

Technical specifications — Geonics EM 61-Mk2

Detector

1.	Brand:	Geonics Limited
2.	Model:	EM 61- Mk 2
3.	Version:	—
4.	Used detection technology:	Time domain electromagnetic induction

Dimensional data

5.	Working length	
	• min. length:	—
	• max. length:	—
6.	Search head	
	• size:	1 x 0.5m
	• weight:	7kg
	• shape:	Rectangular coil
7.	Transport case	
	• weight	
	• with equipment (full):	74kg (2 boxes)
	• dimensions:	106 x 61 x 33cm; 54 x 45 x 56cm
	• hard/soft case (material):	Hard, plywood, aluminium laminated
8.	Weight, hand-held unit:	—
9.	Weight, carrying (operational detection set):	23kg
10.	Weight, additional equipment:	—
11.	Weight distribution/balance:	—
12.	Other specifications:	—

Detection system specifications

13.	Status:	In production
14.	Detectors/systems in use to date:	More than 300
15.	Other types:	5 (production)
16.	Location of use:	Worldwide

Environmental influence

17.	Humidity (limitations):	100%
18.	Temperature (limitations)	
	• storage:	-40°c to +50°c
	• operational:	-30°C to +40°c
19.	Water resistant:	Yes
20.	Shock/vibration resistant:	Yes
21.	Environmental compensation:	Auto for coils
22.	Operational hours/operating endurance :	4h per battery
	• low temperature (around 0°C):	3.5h
	• medium temperature (around 20°C):	4h
	• high temperature (higher than 30°C):	4h

Detection specifications

23.	Calibration/setup	
	• auto/manual:	Auto
	• duration:	10s
24.	Detection range/sensitivity details/ detection performance/working depth	
	• low-metal-content mines:	No
	• anti-vehicle mines:	Yes
	• UXO:	20mm cartridge to 7m; 500lb bomb to 5m, 103mm projectile to 1.3m
25.	Output indicator:	Sound, graphic display
26.	Pinpointing feature:	Yes
27.	Adjustment of search head angle:	n/a
28.	Soil influence:	Extreme magnetic susceptibility

29.	Best use in	
	• sand	Yes
	• peat	Yes
	• clay	Yes
	• ferruginous soil (laterite)	Yes
30.	Optimal sweep speed:	1m/s
31.	Search coil/antenna:	—
32.	Limitations:	—
33.	Interference (with other detectors):	Variable, depending on detector type

Power

34.	Power supply/source:	12V rechargeable gel cell battery
35.	Operating time:	4h
36.	Power supply	
	• weight:	4.5kg
	• no of batteries/size/type:	1
	• rechargeable:	Yes
	• other:	Optional high power battery

Costs

37.	Price:	
	• for one detector:	More than US$5.000
	• reduction for higher quantity:	—
38.	System price	
	• with training:	Additional US$600 per day
	• spare parts:	Available upon request
	• extended warranty:	N/A
39.	Total:	US$21,300
40.	Availability for hire:	Yes

Others

41.	Duration of warranty:	6 months on coils, cables and batteries, 12 months on other components
42.	Additional equipment:	Includes hand-held PC for data storage + GPS capabilities
43.	Additional technical data/information:	—
44.	Compliant standards:	Hazards of electromagnetic radiation on ordnance

Technical specifications — T&A 3D Borehole Radar

Detector

1.	Brand:	T&A
2.	Model:	3D Borehole Radar
3.	Version:	UXO Detector
4.	Used detection technology:	Ground penetrating radar

Dimensional data

5.	Working length:	
	• min. length:	5m
	• max. length:	50m
6.	Search head	
	• size:	4.2m
	• weight:	250kg
	• shape:	Tubular
7.	Other specifications:	—

Detection system specifications

8.	Control of working depth:	—
9.	Status:	Working field system
10.	Detectors/systems in use to date:	1
11.	Other types:	—
12.	Location of use:	Worldwide

Environmental influence

13.	Humidity (limitations):	None
14.	Temperature (limitations)	
	• storage:	-0°C
	• operational:	to +60°C
15.	Water resistant:	Yes
16.	Shock/vibration resistant:	Limited
17.	Environmental compensation:	—
18.	Operational hours/operating endurance	
	• low temperature (around 0°C):	—
	• medium temperature (around 20°C):	—
	• high temperature (higher than 30°C):	—

Detection specifications

19.	Calibration/setup:	
	• auto/manual:	Manual
	• duration:	4h
20.	Detection range/sensitivity details/ detection performance/working depth	
	• low-metal-content mines:	—
	• anti-vehicle mines:	—
	• UXO:	Detection up to 15m, depth up to 30m
21.	Output indicator:	Display
22.	Pinpointing feature:	—
23.	Adjustment of search head angle:	—
24.	Soil influence:	The less conductive the better
25.	Best use in:	
	• sand	Yes
	• peat	Limited
	• clay	Limited
	• ferruginous soil (laterite)	Yes
26.	Optimal sweep speed:	1m/s
27.	Search coil/antenna:	Shielded dipole
28.	Limitations:	—
29.	Interference (with other detectors):	No

Power

30.	Power supply/source:	230V AC/50MHz

Costs

31.	Price:	More than US$5,000
32.	Availability for hire:	Yes

Other

42.	Duration of warranty:	12 months
43.	Additional equipment:	Tripod, winch, surface equipment
44.	additional technical data/information:	—
46.	Compliant standards (civil/military):	—

Technical specifications — Vallon EL 1302D1

Detector

1.	Brand:	Vallon
2.	Model:	EL 1302D1
3.	Version:	Ferrous locator
4.	Used detection technology:	Difference magnetometer using fluxgate principle

Dimensional data

5.	Working length:	Approx. 1,350mm
6.	Search sensor	
	• size:	Length approx. 600mm, diameter approx. 42mm
	• weight:	Approx. 4kg
	• shape:	Tube
7.	Transport case	
	• weight	Approx. 6.3kg
	• with equipment (full):	Approx. 11kg
	• dimensions:	785 x 285 x 140mm
	• hard/soft case (material):	Hardcase/aluminium
8.	Weight, hand-held unit:	Approx. 4kg (with batteries)
9.	Weight, carrying (operational detection set):	Approx. 4kg (with batteries)
10.	Weight, additional equipment:	Head set 100g
11.	Weight distribution/balance:	Balanced around the hand grip
12.	Other specifications:	—

Detection system specifications

13.	Control of working depth:	Sensitivity switch
14.	Status:	In production
15.	Other types:	EL 1303D, VET 1
16.	Location of use:	Worldwide

Environmental influence

17.	Humidity (limitations):	According to MIL STD 810E
18.	Temperature (limitations)	
	• storage:	-54°C to +71°C
	• operational:	-32°C to +60°C
19.	Water resistant:	Yes
20.	Shock/vibration resistant:	Yes
21.	Environmental compensation:	Manual, cannot be used in magnetic soil
22.	Operational hours/operating endurance	
	• medium temperature (around 20°C):	Approx. 20h with alkaline batteries depending on operation periods

Detection specifications

23.	Calibration/setup:	
	• auto/manual:	Manual or automatic
	• duration:	Continual
24.	Detection range/sensitivity details/ detection performance/working depth	
	• low-metal-content mines:	No
	• anti-vehicle mines:	Anti-vehicle mines with ferrous housing: depending on their material and the local interference
size,		
	• UXO:	Depending on their size, material and the local interference
25.	Output indicator:	Audio by built-in loudspeaker or headset, visual by indication meter, optional real-time display on screen of datalogger or PC with evaluation software Vallon
26.	Pinpointing feature:	Yes
27.	Adjustment of search head angle:	Yes
28.	Soil influence:	See item 29

29.	Best use in:	
	• sand	Yes
	• peat	Yes
	• clay	Yes
	• ferruginous soil (laterite)	Limited
31.	Optimal sweep speed:	0 – 1m/s
32.	Search coil/antenna:	Tube with 42mm diameter
33.	Limitations:	Only ferromagnetic targets
34.	Interference (with other detectors):	Same detector type no.

Power

35.	Power supply/source:	Battery
36.	Operating time:	See point 22
37.	Power supply	
	• weight:	6 batteries approx. 400g
	• no of batteries/size/type:	6 EA. 1.5 V round cells (IEC R14) C-size
	• rechargeable:	6 EA. 1.2V Ni-MH batteries RSH 1.8
	• other:	—

Costs

38.	Price:	
	• for one detector:	More than US$5,000
	• reduction for higher quantity:	Yes
39.	System price:	
	• with training:	Upon request
	• spare parts:	Upon request
	• extended warranty:	Upon request
40.	Total:	—
41.	Availability for hire:	Upon request

Other

42.	Duration of warranty:	24 months
43.	Additional equipment:	Datalogger, evaluation software, DGPS, sensor positioning system SEPOS®, multisensor platform
44.	additional technical data/information:	—
46.	Compliant standards (civil/military):	DIN EN ISO 9001: 2000 MIL STD 810E 501.3, 502.3, 503.3, 514.4 MIL STD 461D

Section 4

Combined systems

Vallon VMR1

Vallon, Germany

VMR1 in operation

General description

The **Dual-Sensor-Detector VMR1** is a combined metal detector and ground-penetrating-radar system designed specifically for use in humanitarian demining operations using advanced technology.

Vallon is producing the VMR1 using the techniques of the Vallon Metal Detector VMH3 and a custom designed 1GHz ground penetrating radar designed by ERA Technology Ltd.

The VMR1 is designed to operate first in metal detection mode, where all metal threats are indicated. The operator then uses the ground penetrating radar to confirm the presence of a potential threat. The output to the operator from both the metal detector and ground penetrating radar is by means of audio signals and a visual bargraph. The metal detector audio provides accurate position information and mass of metal indications. The GPR provides accurate position information, depth information and radar cross-section of target information.

VMR1 has two main control interfaces: a mode switch mounted on the main electronics and a control handle, which allows the operator to calibrate the unit and set the sensitivity of either detector by pressing increase and decrease buttons.

Two further visual indicators are mounted on the control handle: one marked MD and one marked GPR. They indicate when the respective sensors are operating. The GPR is self-calibrating when in use by the operator.

A sensor select button on the handle will select the operating sensor. By toggling this control the operator can select either metal detector only, GPR only or both concurrently. The latter would be an option only if enabled by a supervisor using the supervisor interface.

Power supply

The operator can choose whether to operate from internal batteries (D-cells) or by removing them and inserting a connector, operate from a belt battery. The operational life of batteries is said to be up to 5 hours, depending on the age, quality and the capacity of the batteries.

Detectors in use to date

VMR1 is built to a standard appropriate for use in field trials. It is not yet qualified as an operational system, however, and should not be used as a primary detector in a "live" minefield situation until it has been approved. Production is scheduled to start in June 2005.

Factory support

Vallon runs a worldwide servicing network with all current spare parts in stock. Spare parts can be delivered with the relevant maintenance manual directly to the customer for on-site repair.

Operation and maintenance training is offered either at Vallon's own facilities or at a location chosen by the customer.

The operation and maintenance manuals are available in English and German, and other languages on request.

Warranty 24 months.

Maintenance and support

There are no special requirements for technicians or workshop facilities. All tools are standard and available in most workshops. For each detector a maintenance manual is available, with step-by-step explanation for detector repair.

VMR1 control handle

Reported limitations and strengths

No information available at this time.

Technical specifications — Vallon VMR1

Detector

1.	Brand:	Vallon
2.	Model:	VMR1
3.	Version:	—
4.	Used detection technology:	Metal detector with ground penetrating radar

Dimensional data

5.	Working length	
	• min. length:	980mm
	• max. length:	1,410mm
6.	Search head	
	• size:	170mm x 308mm
	• shape:	Oval
7.	Transport case	
	• with equipment (full):	Estimated as 7kg
	• dimensions:	Estimated as 1.2m x 0.35m x 0.35m
	• hard/soft case (material):	Soft
8.	Weight, hand-held unit:	Less than 5kg
9.	Weight, carrying (operational detection set):	Less than 5kg
10.	Weight, additional equipment:	Headset 100g

Detection system specifications

11.	Control of working depth:	Sensitivity adjustment
12.	Status:	Development, production starts in June 2005
13.	Detectors/systems in use to date:	MD/GPR

Environmental influence

14.	Humidity (limitations):	According to MIL STD 810F
15.	Temperature (limitations)	
	• storage:	-55°C to + 75°C
	• operational:	-32°C to + 60°C
16.	Water resistant:	Yes
17.	Shock/vibration resistant:	Yes
18.	Environmental compensation:	Automatic
19.	Operational hours/operating endurance:	Up to 5h depending on battery type and capacity

Detection specifications

20.	Calibration/setup	
	• auto/manual:	Automatic
	• duration:	Continual
21.	Detection range/sensitivity details/ detection performance/working depth:	
	• low-metal-content mines:	Depending on their size, material and local interference
	• anti-vehicle mines :	Depending on their size, material and local interference
22.	Output indicator:	Sound, visual bargraph
23.	Pinpointing feature:	Yes
24.	Adjustment of search head angle:	With a joint
25.	Soil influence:	Adjustable
26.	Best use in:	
	• sand	Yes
	• peat	Yes
	• clay	Yes, but GPR limited
	• ferruginous soil (laterite)	Yes
27.	Optimal sweep speed:	0.2-1.5m/s
28.	Search coil/antenna:	Oval shape with 170 x 308mm
29.	Limitations:	Excluding salt water and heavy clay for GPR only

Power

30.	Power supply/source:	Battery
31.	Operating time:	See point 19
32.	Power supply:	
	• number of batteries/siz/type:	4 EA 1.5V standard batteries D-size
	• rechargeable:	4 EA 1.24V rechargeable battery
	• other:	Belt battery

Costs

33.	Price:	More than US$5,000
34.	Reduction for higher quantity:	Yes
35.	System price:	
	• with training:	Upon request
	• spare parts:	Upon request
	• extended warranty:	Upon request
36.	Availability for hire:	Upon request

Others

37.	Duration of warranty:	24 months
38.	Compliant standards:	DIN EN ISO 9001:2000 MILSTD 810F, 501.4-II, 502.4-I, 503.4, 506.4-III, 514.5 C1

Section 5

Vehicle-mounted detectors

Foerster MINE-CAT 4.600

Institut Dr. Foerster, Germany

MINE-CAT 4.600 array

General description

The **MINE-CAT 4.600** represents a combination of technologies found in the MINEX 2FD 4.500 for vehicle-based research. In mid-2002, it left the prototype stage and has since been tested under various scenarios in the field. Due to its light weight and easy mounting it can be connected to almost all existing vehicles, whether it is needed in front, behind or beside the vehicle.

Basic technical features:

- Continuous wave induction with two primary transmitting frequencies;
- One transmitting coil;
- Multiple receiving coils;
- Automatic compensation soil, salt water, AC fields;
- Ground-learning procedure.

Its three main components are:

- The array itself integrated within a topography-adaption frame;
- Control unit with integrated PC;
- Target marking device.

Working methodology

The MINE-CAT 4.600 needs only one cable as standard connection between the control unit and the array. Data sampling, evaluation and display via the control unit offer the following display of results:

- Object map/list in real time;
- Object marking on field surface in real time.

Integrated filter settings are offering:

- Reduction of false alarms;
- Preselection of object size.

Rough indication of sensitivity:[1]

- TM 62 anti-vehicle mine: approx. 70cm;
- PMN anti-personnel mine: approx 30cm;
- Same sensitivity for low metal content mines like the MINEX 2FD 4.500.

Power supply

Power supply 12VAC or 24VAC (normally fed via the vehicle's power supply).

Detectors in use to date

No information provided by the manufacturer.

Factory support

No information provided by the manufacturer.

Maintenance and support

No information provided by the manufacturer.

Test and evaluation

The MINEX Array 4.550 has been tested by Foerster personnel and has undergone field acceptance trials.

As the detector has recently been introduced to the open market it could not be tested in comparative trials.

Reported limitations and strengths

No information available at this time.

1. According to the manufacturer.

Schiebel VAMIDS™

Schiebel Elektronische Geräte GmbH, Austria

VAMIDS™ drawbed

VAMIDS™ mounted on mine-protected vehicle

General description

VAMIDS™ provides the ability to detect low-metal-content mines from a vehicular platform.[1] The system is ideal for route clearance/verification, area reduction and quality assurance. It can be mounted on virtually any medium- or heavy-duty tactical or civilian vehicle, providing an efficient and cost-effective detection system. The system is designed for use on established (though possibly primitive) routes, but is also ideally suited for clear, open land.

The system is capable of operating at speeds of up to 10km/h while providing real-time detection, which significantly increases the productivity of clearance operations. VAMIDS™ is based upon the proven technology of the AN-19/2 Mine Detecting Set, by combining this technology with a sophisticated visualisation and marking system. VAMIDS™ allows its operators to quickly and efficiently detect landmines and mark the ground prior to clearance.

The VAMIDS™ marking system is designed to accurately mark the location of targets and the cleared lane using an easily identifiable fluid. With up to eight spray nozzles per metre the system provides highly accurate, target-proportional marking capability. The criteria for marking is selected and controlled via the VAMIDS Manager™ software. A wide variety of marking fluids may be used.

Working methodology

The flexible arrays are pulled over the ground, ensuring optimal coverage. The individual detection heads are mounted on a flexible drawbed structure that serves as a wear sheet, both supporting and protecting the assembled detection heads.

VAMIDS™ requires only one dedicated operator, who may be trained on all operational aspects, typically within a day. All functions are controlled, and all parameters are set, using the VAMIDS Manager™ software.

Once the system is calibrated (in a metal-free area), and a functional check is completed, the system is ready for deployment. The VAMIDS™ operator may observe the metal content in the ground under the VAMIDS™ with the real-time display on the system console. The operator has full control over all marking and safety alarm parameters.

Power supply

The control unit is powered from a nominal 12V up to 36V DC standard vehicle battery. The input power is fused and filtered on the power card. All DC-DC converters can operate over an input range from 10V DC to 40V DC thereby providing large margins for the specified nominal battery supply voltage.

Detectors in use to date

VAMIDS™ has been purchased and is used by humanitarian and commercial demining organisations in several countries. No further detailed information is given by the manufacturer.

Factory support

- All systems are covered by a 12-month, no-cost warranty and operator/maintenance training is provided (on site or at the factory as requested) as part of the procurement package. Further training can be provided for a fee;
- Spare parts are available for a period of ten years after purchase. These can be obtained directly from the factory or from the worldwide network of Schiebel agents;
- Operator and maintenance manuals are provided in most major languages (e.g. English, German, Spanish, etc.);
- Schiebel factory repairs or technicians are available to provide additional support worldwide whenever required.

Maintenance and support

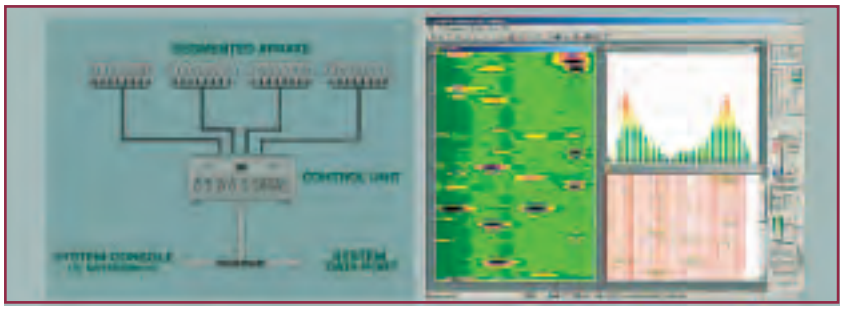
Due to its rugged design VAMIDS™ requires little maintenance and can be upgraded to the latest modification state. Most repairs can be carried out, at field level, by Schiebel-trained personnel. Workshop repairs can be carried out by Schiebel-trained technicians, using the recommended tools and test equipment.

Test and evaluation

VAMIDS™ has been comprehensively field-tested in all climates by the manufacturer and all detector specifications are fully proven. It has also been evaluated and selected by a range of organisations. (No detailed information is provided by the manufacturer).

However the detector has not been tested in comparative trials.

Marking suspect area



VAMID display of scanned area

Reported limitations and strengths

No information available at this time.

1. According to the manufacturer.

Vallon VMV 8

Vallon, Germany

VMV 8 mounted in front of a vehicle

General description

The metal detector **VMV 8** has been designed for the localisation of metal objects in the ground, e.g. metal mines, plastic mines with higher metal content, and UXO.

Quality control is considered to be one of the most suitable applications for this detector.

The unit consists of a search head, waterproof detection and evaluation electronics, and a special PC to display metal parts, to operate the unit, and for the documentation.

The search head is specially designed to meet user needs and allows the following applications:
- mounting in front of the vehicle;
- mounting aside the vehicle;
- trailer version.

The VMV8 has a rugged design and can be operated in all weather and soil conditions as well as climatic zones.

This unit is also suitable for the integration of multi-sensor platforms, including gradient magnetometers, infrared, ground penetration radar or microwave for the detection.

Main components VMV 8:

1. Central electronics in a weatherproof housing with eight overlapping coils;
   - EMI-detection channels based on the pulse induction method;
   - Server electronics with output for Fast Ethernet connection to PC;
   - With connectors for 1 x DGPS, 1 x electronic compass, active (EMI) sensors and test-computer for service;
   - DC voltage: 12-30V;
   - Dimensions in transport box: approx. 410 x 330 x 180 mm (LxWxH).
2. Relay box 16 channels, provided for:
   - 1 channel for braking signal;
   - 8 channels for painting system;
   - 7 channels AUX.
3. Rugged portable notebook computer.
4. Software VALLON EVA2000® 2.0 for data recording and evaluation.
5. Search head made from glassfibre, dimensions approx. 3,000 x 460 mm with eight detector coils integrated detection coil systems. Other dimensions on request.
6. Set of cables.

7. Mounting kit (glassfibre bars).
8. Protective spoiler.

Working methodology

The search head consists of eight electromagnetic sensors emitting pulses, with a short pause between each magnetic pulse. The electromagnetic reaction of metal objects is registered during these pauses at the central control unit.

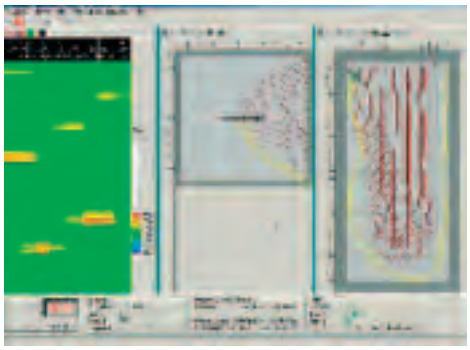
By virtue of the detector's "automatic adjustment", it spontaneously adapts itself to the natural ground conditions. Detection work can be carried out even in adverse soil conditions such as magnetite soil and soils with changing conductivities.

The sensitivity level of the detector is adjustable. The set sensitivity level will remain constant even under changing ground or water conditions.

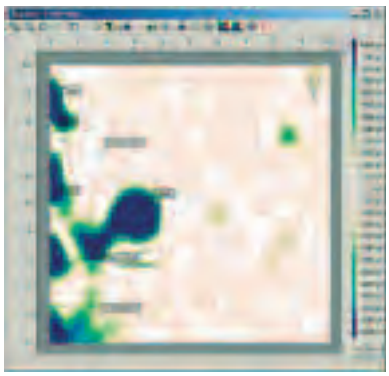
The measuring data are transferred via an Ethernet cable to the PC.

The notebook together with the software VALLON EVA2000® 2.0 provides the complete system operation and data evaluation:

1. Settings.
2. Real-time display of the measured data during data acquisition as measuring curve, colour map or bargraph.
3. Automatic soil adaptation (Autosoil) from the notebook.
4. Signals via 8 or 16 potential-free relais channels for different applications, e.g. brake system, marking system and others.
5. The stored data can be evaluated by means of the software VALLON EVA2000® 2.0 and displayed in form of colour maps or in form of measuring curves. A printout of the survey area shows clearly in a true-to-scale map where metal parts have been left.



Colour navigation map



VMV8 dataview

VMV8 field map evaluation

Power supply

- The power supply of the detector accepts car batteries with 12V or 24V DC. The internal controls stabilise voltage fluctuations between 10-32V DC.
- Safety fuse: 4A.
- DC converter from 12V to 30V is included.

Detectors in use to date

The detectors are in service with several NATO partners, other armed forces and commercial mine clearance organisations.

Factory support

- The manufacturer runs several service centres around the world with spare parts in stock. These can be provided together with the relevant maintenance manual to the customer for repair on site.
- Operation and maintenance training is offered at all Vallon facilities worldwide.
- The operation manuals and the maintenance manuals are available in English and German, and other languages on request.
- Warranty 24 months.

Maintenance and support

There are no special requirements for the technicians or the workshop facilities. All tools are standard and available in most of the workshops. For each detector a maintenance manual is available, with step by step explanation for the repair of the detector.

Test and evaluation

Internal test reports can be provided on request by the manufacturer.

Reported limitations and strenghts

No information available at this time.

1. According to the manufacturer.

Technical specifications — Foerster MINE-CAT 4.600

Detector

1.	Brand:	Foerster
2.	Model:	MINE-CAT 4.600
3.	Used detection technology:	Metal detector working by continuous-wave EMI with two parallel frequencies in combination multiple receiving coils

Dimensional data

4.	Working length	
	• min. length:	1,200mm - 2,500mm depending on customer's request
5.	Search head	
	• size:	(1,200mm-2,500mm) x 310mm x 50mm
	• weight:	Approx. 15kg or more(growing with length)
	• shape:	Rectangular
6.	Topographic adaption	
	• weight:	Approx. 35kg or more (growing with length)
7.	Weight, control unit:	Approx. 8kg/shockproof

Detection system specifications

8.	Status:	Production on request

Environmental influence

9.	Humidity (limitations):	No limitations
10.	Temperature (limitations)	
	• storage:	-57°C to + 70°C
	• operational:	-35°C to + 70°C
11.	Water resistant:	Coil system: yes / Control Box IP 65
12.	Shock/vibration resistant:	Yes
13.	Environmental compensation:	Automatic, control of very agressive soil supported by soil-learn-procedure

Detection specifications

14.	Detection range/sensitivity details/ detection performance/working depth:	
	• low-metal-content mines:	Type 72 A - approx. 19cm
	• anti-vehicle mines :	TM 62 M - approx 70cm
15.	Output indicator:	Real-time on screen and spray-marking
16.	Best use in:	
	• sand	Yes
	• peat	Yes
	• clay	Yes
	• ferruginous soil (laterite)	Yes
17.	Optimal sweep speed:	Diving speed < 1m/s

Power

18.	Power supply/source:	12V AC or 24V DC/consumption < 25W

Costs

19.	System price:	—
20.	Total:	Approx. US$95,000; subject to requested modifications and customers' wishes
21.	Availability for hire:	Available

Others

22.	Duration of warranty:	24 months

Technical specifications

Schiebel VAMIDS™ Vehicular Array Mine Detection System

Detector

1.	Brand:	Schiebel Elektronische Geräte GmbH
2.	Model:	VAMIDS™ Vehicular Array Mine Detection System
3.	Version:	2.0
4.	Used detection technology:	Pulse mode

Dimensional data

5.	Working length	
	• min. length:	Min. 1m array
	• max. length:	Max. 6m array
6.	Search head	
	• size:	1,168mm wide; 613mm long;150mm thick per metre array
	• weight:	20kg per metre array
	• shape:	Search head is round; array is rectangular
7.	Transport case	
	• weight:	—
	• with equipment (full):	—
	• dimensions:	—
	• hard/soft case (material):	—
8.	Weight, hand-held unit:	—
9.	Weight, carrying (operational detection set):	—
10.	Weight, additional equipment:	—
11.	Weight distribution/balance:	—
12.	Other specifications:	—

Detection system specifications

13.	Control of working depth:	Depending on soil and properties of target
14.	Status:	In production
15.	Detectors/systems in use to date:	No comment
16.	Other types:	—
17.	Location of use:	No comment

Environmental influence

18.	Humidity (limitations):	No
19.	Temperature (limitations)	Virtually none
	• storage:	-55°C to +85°C (-67°F to +85°F)
	• operational:	-40°C to +55°C (-40°F to +131°F)
20.	Water resistant:	Yes
21.	Shock/vibration resistant:	Yes
22.	Environmental compensation :	Auto
23.	Operational hours/operating endurance:	Not applicable

Detection specifications

24.	Calibration/setup :	Not applicable
25.	Detection range/sensitivity details/ detection performance/working depth:	
	• low-metal-content mines:	Type 72A –18cm, M14 -14cm
	• anti- vehicle mines:	Metal anti-vehicle at 1m; plastic anti-vehicle nearly all types operational threat depth
at		
	• UXO:	NATO standard 7.62 rounds at 40cm, AK 47 at 30+cm all larger items down to 1m in depth
26.	Output indicator:	Visual, acoustic, data-based, and electric relay-based galvanically separated output
27.	Pinpointing feature:	No
28.	Adjustment of search head angle:	—
29.	Soil influence:	Can operate in light magnetic soil with reduced but normally acceptable performance

30.	Best use in	
	• sand	Yes
	• peat	Yes
	• clay	Yes
	• ferruginous soil (laterite)	No
31.	Optimal sweep speed:	Vehicle velocity 0–15km/h
32.	Search coil/antenna:	8 coils per metre up to 48 coils
33.	Limitations:	Medium and heavy magnetic soil
34.	Interference (with other detectors):	None at distance above 2m separation

Power

35.	Power supply/source:	Standard vehicle battery
36.	Operating time:	—
37.	Power supply:	12 up to 36V DC

Costs

38.	Price:	
	• for one detector:	US$3,000-US$4,000
	• reduction for higher quantity:	Yes
39.	System price	
	• with training:	Included
	• spare parts:	As required
	• extended warranty:	Available
40.	Total:	To be determined
41.	Availability for hire:	Yes

Other

42.	Duration of warranty:	12 months
43.	Additional equipment:	Not applicable
44.	Additional technical data/information:	Available
46.	Compliant standards:	MIL-D-0023359G; ISO 9001

Technical specifications — Vallon VMV8

Detector

1.	Brand:	Vallon
2.	Model:	VMV8
3.	Version:	Vehicle-Mounted Metal Mine Detector
4.	Used detection technology:	Pulse induction

Dimensional data

5.	Working length:	
	• min. length:	1,500mm
	• max. length:	2,084mm
6.	Search head	
	• size:	3,000 x 460mm
	• weight:	35kg
	• shape:	Rectangular
	Spoiler	
	• size:	3,050 x 735mm
	• weight:	15kg
	• shape:	U form
7.	Transport case	
	• weight:	85kg
	• with equipment (full):	160kg
	• dimensions:	3,100 x 780 x 500mm
	• hard/soft case (material):	Wooden case
8.	Weight, hand-held unit:	Not applicable
9.	Weight, carrying (operational detection set):	—
10.	Weight, additional equipment:	—
11.	Weight distribution/balance:	—
12.	Other specifications:	—

Detection system specifications

13.	Control of working depth:	Sensitivity adjustment
14.	Status:	In production
15.	Detectors/systems in use to date:	—
16.	Other types:	VMXV4D for combined metal and UXO detection
17.	Location of use:	Worldwide

Environmental influence

18.	Humidity (limitations):	According to MIL STD 810E
19.	Temperature (limitations)	
	• storage:	-40°C to +70°C
	• operational:	-10°C to +60°C
20.	Water resistant:	Yes up to 1.5m
21.	Shock/vibration resistant:	Yes
22.	Environmental compensation:	Auto
23.	Operational hours/operating endurance	Works with vehicle battery

Detection specifications

24.	Calibration/setup	
	• auto/manual:	Automatic
	• duration:	Continual
25.	Detection range/sensitivity details/ detection performance/working depth	
	• low metal content mines:	—
	• anti-vehicle mines:	Depending on their size, material and the local interference
	• UXO:	Depending on their size, material and the local interference
26.	Output indicator:	Sound and notebook display
27.	Pinpointing feature:	Yes
28.	Adjustment of search head angle:	Manual
29.	Soil influence:	Automatic and adjustable

30.	Best use in:	
	• sand	Yes
	• peat	Yes
	• clay	Yes
	• ferruginous soil (laterite)	Yes
31.	Optimal sweep speed:	0.2 – 1.5 m/s
32.	Search coil/antenna:	Rectangular 3,000 x 460mm
33.	Limitations:	No
34.	Interference (with other detectors):	Distance of 16m

Power

35.	Power supply/source:	Car battery
36.	Operating time:	See point 23
37.	Power supply	
	• weight:	—
	• no of batteries/size/type:	Car battery 12 or 24V
	• rechargeable:	Yes
	• other:	Converter from 12V to 30V

Costs

38.	Price:	
	• for one detector:	More than US$5,000
	• reduction for higher quantity:	Yes
39.	System price:	
	• with training:	Yes
	• spare parts:	Yes
	• extended warranty:	Upon request
40.	Total:	From US$80,000 to US$160,000
41.	Availbility for hire:	Upon request

Other

42.	Duration of warranty:	24 months
43.	Additional equipment:	Colour marking system upon request
44.	additional technical data/information:	—
46.	Compliant standards (civil/military):	DIN EN ISO 9001:2000 MIL STD 810F, 501.4, II, 502.4-I, 502.4-II, 503.4, 506.4-III, 514.5C1

Section 6

Personal protective equipment

ENVOTECH Apron

ENVOTECH Co Ltd., Cambodia

Backless apron is designed to overlap with the visor

General description

The **ENVOTECH Apron** provides frontal protection from the shoulders to the upper thighs. Specially fixed extensions are intended to protect the vulnerable area of the armpits. The modular system consists of backless apron, sleeves and backless trousers. The front ruff is designed to overlap the visor to ensure continous protection for both the upper body and the face.

The lightweight design helps to minimise hazards caused by heat stress and fatigue. The apron is highly suited for hot and humid climates.

The outer cover is washable and can be replaced if worn out. According to the manufacturer the apron design is most suitable for the kneeling position.

Protective performance/mass

Protection level	Material specifications	Mass
V50- 450m/s according to STANAG 2920	Not given	Apron: 1.8kg (medium size) Trousers: 1.8kg

Colour options and size

The apron is available in dark blue, and other colours on request.

Test and evaluation

Test reports can be provided by the manufacturer on request. According to the manufacturer, the equipment has been regularly tested by H.P. White Laboratories, Maryland in the US.

Cost

Vest: US$358.
Trousers (medium size): US$198.

Force Ware Mine Protection Apron

Force Ware, Germany

Protection apron with open back design

General description

The **Force Ware Mine Protection Apron** is made of Kevlar and Ballistic Aramid. This composite design reduces weight and increases the level of protection. The internal layers are covered with a water resistant cover made of coated material. A transparent pocket is provided for user details such as name, blood group or rank. This pocket is made of polycarbonate material to reduce the risk of potential secondary fragmentation.

A formed shoulder support makes the armour comfortable to wear and easy to put on or remove (no belts or clips). An additional pad can be fitted to provide extra protection to the throat area if short visors are worn.

The one-piece garment provides frontal protection from the sholders to the upper thighs. The apron is lightweight and its open back design allows body heat to easily disperse when performing demining activities over longer periods in hot and humid climates.

Protective performance/mass

Protection level	Material specifications	Mass
V50- 450m/s according to STANAG 2920	Kevlar, ballistic Aramid	2.7kg

Color options and size

The standard size of the apron is 91 x 48.5cm. No information on the range of colour options has been provided by the manufacturer.

Test and evaluation

Test reports can be provided by the manufacturer on request.

Cost

Not given.

Mine Protection Suit "MPS"

Force Ware, Germany

Mine Protection Suit "MPS" with attached arm and leg protection

General description

The Force Ware **Mine Protection Suit "MPS"** is made of three layers of Dyneema Fraglight material which is specially designed for protection against fragments of exploding landmines or artillery shells. The MPS is designed to be a flexible platform providing continous protection against fragmentation, overpressure and heat. The system consists of a jacket and optional arm and leg protection.The outer cover is washable at 40°C. A pouch can be attached to carry accessories needed by deminers. The suit is currently available in one size, however, according to the manufacturer, it can be adapted to fit all sizes.

Protective performance/ mass

Protection level	Material specifications	Mass
V50- 474m/s or 650m/s according to STANAG 2920	Dyneema Fraglight	Suit complete: 3kg Jacket: 1.5kg Leg protection: 0.84kg Arm protection: 0.66kg

Color options and size

The suit is currently available in one size. No information on the range of colour options has been provided by the manufacturer.

Test and evaluation

Test reports can be provided by the manufacturer on request.

Cost

Not given.

EOD Squad Suit M-98

Force Ware, Germany

EOD Squad Suit M-98 provides 360° protection

General description

The **EOD Squad Suit** is designed for bomb disposal experts and provides 360° protection against fragmentation, overpressure and heat.
The modular system consists of the following components:

- Protective trousers (left and right), IIA, V50>400m/s as per MILSTD 662.E;
- Protective sleeves (left and right), IIA, V50>400m/s as per MILSTD 662.E;
- Protective vest (genital protection, front and back), IIIA, V50>500m/s as per MILSTD 662.E;
- Belt set;
- Carrying bag;
- Helmet M-97 with visor.

The suit is equipped with Velcro fasteners for quick removal. Tools for carrying out EOD tasks can be stowed away in four front pockets. A mesh ventilation that helps to reduce the risk of heat stress for the operator can be incorporated on request.

Protective performance/mass

Protection level	Material specifications	Mass
Trousers and sleeves: V50of >400m/s Vest: V50 of >500m/s	Not given	Suit complete: 21kg

Color options and size

Not given.

Test and evaluation

Test reports can be provided by the manufacturer on request.

Cost

Not given.

LBA 372-DMV2 and LBA 371-DMV1 Demining Vests

LBA International Ltd., United Kingdom

LBA 371 DMV1 demining vest

LBA 372 DMV2 demining vest

General description

The **LBA 371 & 372 Demining Vests** have been recently developed to meet the demand for equipment specifically designed for mine clearance work. The vests are designed to offer maximum coverage whilst keeping flexibility and weight a priority.

The LBA 371 & 372 Demining Vests cover all the major areas of the upper body that could be life threatening if damaged, such as the groin, armpits and neck. The front armour section is of a one-piece design with a unique sewing, and permits a three dimensional neck protection without any joins in the Aramid fibres. The 372 offers enhanced groin and shoulder protection compared to the 371.

The manufacturer can offer a range of protection levels. However in practical terms the fragmentation system F2 level has been found to be the most appropriate level (Level F2 offer a V50 against a 17 grain fragment of 450 m/s).

Panels of water-repellent-woven Aramid provide the protection. The Aramid used is a special construction that provides the best protection against all sizes of fragments, while still keeping the system light and flexible. These packs are tailored to provide the maximum extent of protection. The design of the armour allows a high degree of flexibility to accommodate body shape variations and avoid restrictions to movement. The jacket has removable armour packs so that they can be cleaned. Spare covers are also available.

The armour in the jacket may be removed and the outer shell washed as required. The suit can be manufactured in a range of machine washable fabrics, including Cordura and fire retardant.

Protective performance/ mass

Protection level	Material specifications	Mass
V50- 450m/s according to STANAG 2920	Aramid fibre	Version 371 (medium size):1.9kg; Version 372 (medium size): 3.4kg

Colour options and size

The standard colour is Navy Blue, but other colours could be supplied depending upon quantity. The vests are available in small, medium, large and extra large, and other sizes are available on request.

Test and evaluation

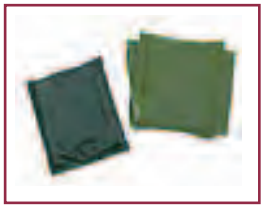
Test reports can be provided by the manufacturer on request.

Cost

Not given.

Advanced Clearance Ensemble (ACE)

Med-Eng Systems Inc., Canada



ACE ballistic

ACE blast plate

ACE trousers

ACE vest

ACE sleeves

General description

The **ACE (Advanced Clearance Ensemble)** has been designed to provide multi-threat protection for soldiers engaged in a range of operational scenarios during peacetime and conflict. Soldiers involved in mine, UXO and booby-trap clearance can easily reconfigure their PPE to match the determined threat and to suit task requirements without assistance.

The ACE features a vest with removable sleeves and trousers that offer protection to the lower limbs. The vest can be configured with interchangeable blast and ballistic plates. The blast plates offer significant protection against the effects of blast-type anti-personnel mines: overpressure, fragmentation, impact/acceleration and heat/flame. The ballistic plates increase the bullet resistant level of the vest from its standard NIJ[1] level IIIA to an NIJ level III (7.62 mm rounds).

The ACE's scaleable, modular components can be put on and taken off. It is designed for use with a full-face visor, such as Med-Eng's VBS-250 and VBS-450 visors for continuous frontal protection over the upper body, neck and head.

Protective performance/mass

Protection level	Material specifications	Mass
V50 level according to NATO STANAG 2920	Ballistics Aramid materials	Vest, blast plates and pouch, trousers and sleeves (medium size): 15.5kg

Colour options and size

The standard available colour is dark green.

Test and evaluation

Like all Med-Eng products the ACE has been subjected to intensive live blast testing. In the test series instrumented anthropomorphic mannequins have been used. Internal test reports can be provided by the manufacturer on request.

Cost

Not given.

1. US National Institute of Justice.

Med-Eng Demining Apron

Med-Eng Systems Inc., Canada

Med-Eng Demining Apron

General description

The **Med-Eng Demining Apron** addresses the need for comfort and flexibility while providing basic protection against threats from blast anti-personnel mines. The apron is lightweight and its open back design allows body heat to disperse when performing demining activities over long periods in hot and humid climates.

The Demining Apron is a one-piece garment that can be easily put on or taken off without assistance. It provides frontal body protection from the shoulders to the upper thighs. Its rigid chest plate combines with either Med-Eng's Lightweight Demining Helmet's visor or the VBS-250 and VBS-450 visors for continuous frontal protection over the upper body, neck and head. To reduce the risk of neck strain, the Demining Apron's weight is distributed around the hips.

Protective performance/mass

Protection level	Material specifications	Mass
V50 level according to NATO STANAG 2920	Layered Aramid fiber	—

Colour options and size

The standard colour of the Demining Apron is charcoal gray. The Demining Apron is made in two sizes, designed to fit the full range of user sizes. The open back design and adjustable straps ensure that each size properly fits the range of adult body proportions.

Test and evaluation

Like all Med-Eng products, the ACE has been subjected to intensive live blast testing. In the test series, instrumented anthropomorphic mannequins were used. Internal test reports can be provided by the manufacturer on request.

Cost

Not given.

Lightweight Demining Ensemble (LDE)

Med-Eng Systems Inc., Canada

LDE apron

LDE sleeves

LDE trousers

General description

The **Lightweight Demining Ensemble (LDE)** is a flexible and lightweight platform. It provides continuous frontal protection against overpressure, fragmentation and heat/flame from blast anti-personnel mines. The modular system consists of a sleeveless, backless apron and backless pant. When worn with its optional accessories (sleeves, back protector and LDE breast and groin steel add-ons), it provides enhanced protection.

The LDE's lightweight design helps reduce fatigue and heat stress for users working several hours at a time in a wide range of environments, including hot and humid climates.

The LDE components are made of soft and rigid ballistic materials, comprising:

- A sleeveless and backless apron which includes integrated groin and chest protection technology; and
- A backless pant which includes thigh and shin plates for greater protection.

The chest plate of the LDE apron integrates with Med-Eng's Lightweight Demining Helmet's visor and the VBS-250 and VBS-450 visors for continuous frontal protection over the upper body, neck and head.

The LDE's optional accessories include sleeves, a back protector and ballistic add-ons. The sleeves and back protector use soft ballistic materials. The sleeves have zippers running along the rearward seam and can be unzipped from both the top and bottom as required for improved ventilation. The ballistic add-ons fit into a plate pouch on the front of the LDE apron.

A trained user can don the LDE in around two minutes without assistance. It can easily be removed in less than one minute.

Protective performance/mass

Protection level	Material specifications	Mass
V50 level according to NATO STANAG 2920	Layered Aramid fibre	Apron with trousers (medium size): 8.56kg

Colour options and size

The standard available colour is charcoal grey. The LDE is available in five standard sizes: extra small, small, medium small, medium, and large. The open back design and adjustable straps ensure that each size properly fits a range of adult body proportions.

Test and evaluation

Like all Med-Eng products the ACE has been subjected to intensive live blast testing. In the test series instrumented anthropomorphic mannequins have been used. Internal test reports can be provided by the manufacturer on request.

Cost

Not given.

Fender HPB Demining Apron

Rofi Industrier, Norway

Fender HPB Demining Apron

General description

The **FENDER Demining Apron** was designed in cooperation with demining organisations working in Afghanistan to meet the specific requirements for demining in that environment. The design provides protection for the deminers when operating the metal detector in an upright position, as well as in both squatting and kneeling position during prodding.

The FENDER protective ensemble consists of a vest unit covering the front, sides, shoulders, neck and upper part of the back, including a second collar functioning as the protection between the vest and the visor. The lower part consists of a detachable apron with straps to provide comfortable and functional protective clothing.

The ballistic inserts of the vest can easily be removed, and the outer cover can be washed in a washing machine at temperatures up to 40°C. The apron can be cleaned using a brush and wet cloth.

Protective performance/mass

Protection level	Material specifications	Mass
V50- 450m/s according to STANAG 2920	Aramid fibre	4.9kg (large size)

Colour options and size

Outer cover (vest): Cordure, 1000 denier, UN blue.

Cover, lower part: PVC coated polyester, 900 denier, 600g/sqm, dark blue.

The demining ensemble is available in small, medium, large and extra large.

Test and evaluation

The Fender HPB was tested by the UNMACA. Internal test reports are available through the Programme Manager of UNMACA.

Cost

Not given.

RAVELIN Demining Vest

Rofi Industrier, Norway

RAVELIN Demining Vest

General description

The **RAVELIN Demining Vest** was designed in cooperation with Norwegian People's Aid and Danish Church Aid to meet the specific requirements for demining in tropical climates. The design provides protection for deminers operating a metal detector in an upright position, as well as in both squatting and kneeling positions during prodding.

The RAVELIN protective ensemble consists of a vest unit covering the front, abdomen, sides, shoulders and neck, including a second collar functioning as the protection between the vest and the visor. Rofi offers three different versions of the RAVELIN vest, OB (open back strap system), HPB (half-protected back) and PB (protected back).

The ballistic inserts of the vest can easily be removed, and the outer cover can be washed in a washing machine at temperatures up to 40°C.

Protective performance/mass

Protection level	Material specifications	Mass
V50- 450m/s optionally 600m/s according to STANAG 2920	Aramid fibre	2.2kg (large size – V50 450m/s)

Colour options and size

Outer cover (vest): Cordura, 1000 denier, UN blue or red. The demining ensemble is available in small, medium, large and extra large.

Test and evaluation

Test reports can be provided by the manufacturer on request.

Cost

Not given.

In use to date

Used or purchased by many organisations, including Danish Church Aid, Danish Demining Organisation, Norwegian People's Aid, RONCO, Swiss Federation for Demining, and the US State Department. The vest is currently used in demining projects in Afghanistan, Angola, Bosnia and Herzegovina, Croatia, Eritrea, Ethiopia, Iraq, Iran, Mozambique, Oman, Sri Lanka, Sudan, and Yemen.

SADEC Apron/SD 450 Apron

Security Devices (PVT) Ltd, Zimbabwe

SADEC Apron

General description

Both aprons cover the deminer's body from the shoulder to mid-thigh, including the genital area. They are lighweight and their open-back design allows body heat to disperse when performing demining activities in hot climates and free movement of the arms. The protective performance ensures basic protection against threats from blast anti-personnel mines.

One of the main features is the one- piece design which aims to maintain integrity during a blast. The aprons are secured with clips which are easily accessible by the wearer and can be operated with one hand. No Velcro® has been used. The outer cover is washable and can easily be replaced.

Protective performance/mass

Protection level	Material specifications	Mass
V50- 450m/s according to STANAG 2920	SADEC Apron: balistic Aramid SD 450 Apron: Kevlar	 3.5kg 3.5kg

Colour options and size

The demining aprons can be delivered in orange, navy blue or royal blue. Information on the availability of different sizes has not been given by the manufacturer.

Test and evaluation

Test reports can be provided by the manufacturer on request.

Cost

Not given.

Visors

	Force Ware	LBA International Ltd
		
Protection level	V-50 (270m/s)- STANAG 2920	V-50 (240 to 650m/s)NATO STANAG 2920 using a 17 grain projectile
Material	5mm polycarbonate	5mm polycarbonate
Weight	1kg	Weight of the visor not given. Weight of the Tetramid Helmet™ is 1.085kg (large size without visor)
Visor protected area	690cm^2	Not given
Features	Visor can be supplied with the following fittings: ➢ Velcro and polycarbonate head support ➢ Helmet attachment fittings ➢ A 0.75cm polycarbonate scratch shield is part of the purchase package	➢ Head band is fully adjustable for both girth and depth. ➢ Visor is hinged and can be lifted and closed at will. ➢ Headband is supplied separately from the visor. ➢ Visors can be fitted optionally to fragmentation and non-fragmentation helmets (see picture below).
Options		

Med-Eng Systems Inc.	Security Devices
	
V-50 (250m/s)In accordance with NATO STANAG 2920 and MIL SPEC 622E, using a 17 grain projectile	V-50 (250m/s)
6mm (0.25») polycarbonate	5mm polycarbonate
1.7kg (3.7lb)	1kg including bag and visorband
Not given	1,250cm^2
➢ Lightweight, ventilated shell with a four-point retention system and full-face polycarbonate visor. ➢ Visor locks in the raised position during rest periods and in the lowered position during operations. ➢ Integrates with the LDE Demining Ensemble and the Demining Apron to provide continuous frontal protection.	➢ Soft headbands for maximum comfort and durability ➢ Supplied with a protective bag ➢ Removable and washable sweatband ➢ The visor has a replaceable 0.7mm polycarbonate scratch shield. ➢ The scratch shield is of low cost and can easily be replaced ➢ Visor can be mounted on a fragmentation helmet (see picture below)
Self-adhesive anti-fog appliqué	➢ Scratch shield ➢ Cotton sun hat 

Annex 1

Assessment of detection technologies

The following table presents a schematic, non-exhaustive overview of several landmine and minefield detection technologies. Some of them have already been fielded, while others stand a serious chance of being fielded in the near future. There are undoubtedly other technologies which could find their way into humanitarian demining, such as acoustic/seismic methods (which seem to possess quite a low false-alarm rate, but are still quite complex, and limited in target depth as well as detection speed), or other techniques which look appealing mostly for specific applications (for example, Electrical Impedance Tomography for confirmation tasks in wet environments).

Most technologies are stand-alone (i.e. they can be used by themselves) but can also be used in combination with others. Comments on multi-sensor systems are provided where appropriate, and in a separate section at the end of the table.

In some cases comments on cost factors have been added as well. These have obviously to be weighted against the benefits derived from the use of the corresponding technology.

The *Application Type* has been schematically subdivided as: hand-held (HH), vehicle-based (VEH) and airborne (AIR), as well as in close-in (CI) vs. remote (REM). Although most of the research carried out so far has focused on the close-in detection of individual mines, wide-area remote minefield detection methods could be very important for area reduction tasks. The *Potential for HD* has been mostly evaluated with respect to the mainstream applications within humanitarian demining.

The *Technology Readiness* estimation is a qualitative measure based, as in the EUDEM report (Bruschini et al), on the known state of advancement of R&D, the demonstration of detection capabilities useful for humanitarian demining, as well as the demonstration of building a practical system. The resulting list is undoubtedly subjective. Additional technology readiness estimations can be found in MacDonald et al and Sahli, Bruschini and Crabbe.

Finally, although the emphasis is here on sensor technologies, it should be noted that a substantial contribution to improving the efficiency of the demining process has come from Information and Communication Technologies (ICT), such as information management (e.g. IMSMA) or positioning systems (GPS, DGPS). In the future we can expect to move towards a coherent framework in which all available information over a given area is integrated and used, with ICT such as integrated GIS environments, image interpretation methods, and decision-support systems, playing a prominent role (Cornelis and Sahli).

Table of technologies

Technology	Operating Principle/ Application Type[1]	Strengths
Enhanced Probes/Prodders	Can be implemented either as passive or active probes (e.g. force feedback measuring or drilling probes, respectively), or as sensor-enhanced tools, including for example acoustic/ultrasonic sensors or metal detectors in the tip of the probe. Application Type: CI: HH.	Enhancements of currently used and well known manual tools. Force feedback probes signal when excessive force is exerted. Drilling probes can be used to enhance penetration in hard soils. Sensor enhanced probes are meant to be used for target recognition (e.g. plastic, rock or metal).
Magnetic **Magnetometers**	Rely on the influence of nearby ferromagnetic objects, on top of the Earth's magnetic field. Are called gradiometers when used in a differential arrangement. Application Type: CI: HH, VEH (arrays).	Very sensitive devices. Are routinely employed to detect large ferromagnetic objects such as UXO and can be effective at depths of several metres. Gradiometers remove the background due to the earth's own magnetic field, and other disturbances.
Electromagnetic **EM Induction ("Metal Detector")**	A time-varying current in a coil generates an electromagnetic field, which induces electric ("eddy") currents in metallic objects (kHz to MHz frequency range[3]). Effect can be enhanced for magnetic objects. Detector "illuminates" an area roughly as large as the sensor head ("footprint"). Application Type: CI: HH, VEH (arrays).	Well established technology (HH; vehicle-based arrays are more recent developments). Indicative detection limits (can also depend on ground conditions): shallow (about 10-15cm for minimum-metal mines, 20-30cm for mines with an appreciable metallic content, and 50-70cm for UXO and metallic mines). Greater depths reachable with large loop systems.
Ground Penetrating Radar (GPR)	Detects radio waves reflected off the mine's surface(s), the amount of reflected energy depending also on the mine's size and shape. Works as a target-soil electrical contrast sensor in a slightly smaller frequency band than cellular phones/microwave ovens (GHz frequency range).Can produce a fuzzy depth "image" by scanning the suspected area, and/or using an antenna array. Application Type: CI: HH, VEH (arrays).	Capable of detecting entirely non-metallic objects (e.g. minimum-metal mines). Well established for a number of applications (civil engineering, geology, archaeology). Can provide target depth information. Could be very useful in stand-alone mode for selected applications (e.g. deep minimum-metal anti-tank mines). Is rather insensitive to small metallic debris. Most GPR use very low power and do not present any radiation hazard.
Microwave Radiometers	Passive sensor, works like a power meter in the microwave band (similar frequency range as GPR - GHz range), measuring the microwave radiation coming from an object. Relies on the microwave "temperature" contrast between the "warm" ground and a "cold" mine. Application Type: CI: HH, VEH. REM: possible for large surface laid objects.	Surface or shallowly buried objects, e.g. as a complement to GPR. Detection depth depends strongly on operating frequency, soil humidity and conductivity, mine case (metal or plastic) and size (large anti-tank are much easier to detect than small anti-personnel mines). Best results likely for large metallic objects in dry soils. In principle simpler than GPR.

Limitations	Potential for HD/ Estimated Technology Readiness[2]
Hard ground and other soil objects (e.g. rocks). Depending on the sensing modality, physical contact with the target may still be necessary. Sensor enhanced tools ("smart probes") will be much more expensive than ordinary tools.	Although potential looks interesting, in particular for simple modifications (force feedback and drilling tools) and/or for training purposes, no deployment seems to have taken place so far. Estimated Technology Readiness: High.
(For demining) Do not react to non-ferromagnetic targets.	Well established technology. Are only used in humanitarian demining when a real need exists (e.g. UXO only, or deeply buried UXO). Estimated Technology Readiness: High.
Magnetic (e.g. laterite rich) or strongly conductive soils. Ground compensation techniques can reduce detector sensitivity. Very small (minimum-metal mines) and/or deep targets, low conductivity metals (e.g. stainless steel). Footprint size decreases with depth (conical footprint). Electromagnetic interference (e.g. power lines). High false alarm rate caused by metal fragments, etc.	Well established technology. Efficiency limited by metallic debris (metal – not mine! – detector). Recent improvements in soil signal suppression (fielded systems). Appealing but challenging innovations: target identification and parameter estimation (e.g. target depth/size), imaging applications, and sensors other than coils. Estimated Technology Readiness: (enhanced MDs) Medium-High.
Wet and/or clay rich soils (increasing attenuation of radio waves). Soil inhomogeneities (roots, rocks, water pockets), strongly uneven ground surfaces, soil moisture profile fluctuations. Very dry soils when looking for plastic objects (reduced electrical contrast). Small anti-personnel mines present a considerable challenge. Need to balance resolution (better at higher frequencies) with depth penetration (better at lower frequencies).	Most mature of all alternative technologies, subject of extensive studies and trials. Preferred combination is with MD.Advanced HH prototypes now available for extensive testing. Depending on the configuration, the GPR can be confirmatory after the MD, to reduce its false alarm rate.Vehicle-based systems mostly developed and tested for military applications (especially route clearance). Estimated Technology Readiness: Medium-High.
Less effective in wet soils. Clear depth limitations. Need to balance resolution (better at higher frequencies) with depth penetration (better at lower frequencies). Has to be protected from radio frequency interference.	Integration with GPR possible (can use same antenna).Potential for HD seems limited.Active systems possible ("illuminate" target with microwaves), may offer enhanced contrast. Estimated Technology Readiness: Medium.

1. HH: Hand-held, VEH: Vehicle-based, AIR: Airborne; CI: Close-in detection, REM: Remote detection.
2. L: Low, M: Medium, H: High.
3. 1 kHz=1000 Hz=1000 times/ second. 1 MHz=1000 kHz, 1GHz=1000 MHz.
4. Bulk explosive detection techniques a llow the direct detection of a macroscopic mass of explosive material.

Table of technologies

Technology	Operating Principle/ Application Type[1]	Strengths
Trace Explosive Detection	Aims at replacing, or at least complementing, mine detection dogs (artificial "dog's nose"). Principle is the identification of microscopic residues of the explosive compound, either in vapour or in particulate form (or both). Sample acquisition — of the air, vegetation or soil — is crucial. Filtering to increase concentration is possible. A sample has to be acquired in the field. It can then be directly used in a portable detector, or has to be transported to the analytical device in the REST (Remote Explosive Scent Tracing) approach. (REST is already used by some organisations with dogs, e.g. for road verification.) Application Type: CI or REM.	Can potentially detect picogram ($1{:}10^{12}$ grams) level samples of explosive material at the detector, or ppt (parts per trillion, $1{:}10^{12}$) concentrations. At least in one case (Nomadics FIDO™) even greater sensitivities have been achieved in the field for TNT, possibly comparable to those of dogs. Comparisons are often carried out with dogs (e.g. Nomadics) – however, there does not seem to be general agreement yet on how dogs manage to find mines and what they are actually sniffing. Trace detection is in routine use in other applications (e.g. aviation security).
Bulk Explosive Detection[4] / Electromagnetic **(Nuclear) Quadrupole Resonance (NQR)**	NQR is an electromagnetic resonance screening technique used to detect certain chemical elements such as Nitrogen 14 (^{14}N), a constituent of explosives found in landmines. A low-intensity radio frequency signal is applied to the material, in a frequency range slightly higher than metal detectors. The alignment of the ^{14}N nuclei is altered. The nuclei then return to their original state, producing a characteristic radio signal (detection is similar to tuning a radio to a particular station). Coils similar to those of metal detectors are used. Application Type: CI: HH (power issues), VEH (especially for anti-tank mines on roads).	NQR is a derivative of (Nuclear) Magnetic Resonance, which is routinely used for example in medical diagnostics, without the need for an external magnetic field. The chemical structure of the object under analysis, and therefore the uniqueness of a molecule's electric field, allows NQR technology to be highly compound specific (each explosive has a unique signature). NQR has potentially a very low false alarm rate. NQR is being investigated for other security related applications (e.g. aviation security). No nuclear radiation is involved.
Bulk Explosive Detection / Neutron Based **Neutron Backscattering**	Fast neutrons are shot into the ground and slowed down by collisions with light nuclei — in particular hydrogen — in the soil and in the mine's explosive (and casing if plastic). Some of the resulting slow neutrons come back and are detected, providing a measure of the hydrogen content of the material. Explosives and plastics are more hydrogen-rich than average (dry) soil. Application Type: CI: HH, VEH possible.	Probably the simplest neutron-based technique; can use a weak radioactive source. Can be integrated with a metal detector in HH equipment. Similar devices are in use in a number of other fields (e.g. petroleum industry). Fast neutrons can penetrate a few cm of steel (e.g. UXO). Imaging might be achievable, to reduce the false alarm rate.

Limitations	Potential for HD/ Estimated Technology Readiness[2]
Trace quantities available for detection might very largely vary in quantity and quality (substance types) in similar situations, and can be very small. Explosive fate and transport in soil: complex effects, strongly dependent on any water flow (large influence of environmental parameters). Weather and soil conditions can lead to samples not being reproducible. Direct vapour detection seems to be more difficult in arid areas. Cross contamination and handling issues are of great importance — experimental conditions can be hard to control/reproduce. Possible problems due to interfering chemicals, and explosives residues due to devices which have detonated.	Strong potential for area reduction (declare an area free of contamination) and verification, rather than the detection of individual mines. Up to now most sensors either have insufficient sensitivity, are too slow or too large to be used in routine field applications. Even if sufficient sensitivities are achieved, extensive field trials are necessary to establish an appropriate methodology. The possibility of detecting traces of explosive- and/or mine-related substances, as well as surface or soil sampling, might also be well worth considering in the future. Estimated Technology Readiness: Medium-High.
Detection times are of a few seconds to tens of seconds, depending on type, quantity and depth of the target substance. Impossible to detect substances fully screened by metallic enclosures, e.g. within UXO. Detecting TNT is much harder than RDX. Weak signals — signal averaging, shielding and active cancellation of interference are necessary, including radio frequency interference and spurious signals due to piezoelectric responses from silica in the soil (quartz). TNT cast in mines is usually a solid solution of different crystalline forms, which can affect the characteristic frequency response.	For confirmation type of applications. Very promising for RDX and tetryl, and/or confirmation of shallow-buried plastic-cased anti-tank mines. Power requirements are considerable and complicate the design of HH equipment. Application for small buried anti-personnel mines still appears to be extremely elusive for TNT (unfortunately TNT is much more common than RDX in landmines!). As electronic systems become cheaper and more powerful it may be possible to substantially improve performance in the future. Estimated Technology Readiness: Medium.
As water is nothing but hydrogen and oxygen, this technique will stop working starting from a given soil humidity. Soil non-homogeneities and surface variations can cause false alarms. Limited target burial depth. Shielding is required if the source strength is increased.	Is adapted to dry or slightly humid environments. Working with radioactive sources, although routine in other applications, requires a certain number of precautions. More likely to be used for confirmation rather than detection. Estimated Technology Readiness: Medium

1. HH: Hand-held, VEH: Vehicle-based, AIR: Airborne; CI: Close-in detection, REM: Remote detection.
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3. 1 kHz=1000 Hz=1000 times/second. 1 MHz=1000 kHz, 1GHz=1000 MHz.
4. Bulk explosive detection techniques a llow the direct detection of a macroscopic mass of explosive material.

Table of technologies

Technology	Operating Principle/ Application Type[1]	Strengths
Neutron Analysis	Other neutron based systems are composed of a *neutron source* to produce the neutrons that have to be directed into the ground, and a *detector* to characterize the outgoing radiation, usually gamma rays (high energy X-rays), resulting from the interaction of the neutrons with the soil and the target. Fast Neutron Analysis (FNA) is based on the interaction of fast neutrons. Thermal Neutron Analysis (TNA) relies on slow neutrons, which can be produced by slowing down fast neutrons from small radioisotopic sources, or from portable electronic neutron generators. A number of derivatives of these techniques exist. Application Type: CI: VEH.	Fast neutrons can penetrate a few cm of steel (e.g. UXO). FNA: by characterising the outgoing gamma rays it is possible to calculate the elemental proportions (how much of each element Carbon, Nitrogen, Oxygen) is present with respect to the others) — in order to determine the type of substance under analysis (all explosives are composed of C, N, O, and Hydrogen that is not detectable by pure FNA, in different proportions). TNA is based on the detection of characteristic gamma rays emitted by the nitrogen nuclei, and features high sensitivity to nitrogen concentration. (Explosives are more nitrogen-rich than average soil.) FNA has the potential of delivering better results than TNA.
Remote Sensing Techniques **(Electro-)Optical**	Earth surface remote imaging with sensors working in the visible, Infrared (IR) and/or Ultraviolet (UV), to detect characteristic image features. In some circumstances can also detect anomalies in the light emitted or reflected by soil and vegetation patches above buried mines (soil disturbances and vegetation stress).Performances can be increased by using multi- or hyperspectral cameras, which operate over several wavelength bands and provide more information than images from common broadband cameras. Other remote sensing techniques are sometimes added (e.g. radar). Application Type: REM: AIR, VEH.	Aerial remote sensing in general enables reduced scan time (wide area detection). Infrared (heat) sensing can detect the thermal contrast between a mine and the surrounding soil (due to differences in thermal conductivity). Multispectral imaging has the advantage of measuring different physical parameters simultaneously, and without major spatial co-registration problems. A number of techniques, such as change detection, multi-temporal analysis and image fusion, can be used to extract features from the recorded (high-resolution) images, including space-borne imagery.
Multi-Sensor Systems	Combination of several sensors in order to exploit complementary information. Is in fact already implemented in the field when combining manual methods with metal detectors and/or mine detection dogs. Some multi-sensor (MS) systems can be made HH. VEH MS platforms are meant to be used for rapid surveying of large areas, in particular roads or moderately off-road areas. Airborne MS platforms can be used for the previously described *remote sensing* applications.	Underlying rationale: exploitation of different sensing principles leads to more reliable detection/classification results by combining different pieces of incomplete or imperfect information. Use of a confirmation sensor can simplify system design and analysis, and come closer to current "sequential" operational procedures. Some requirements, such as power consumption, can be relaxed for VEH applications.

Limitations	Potential for HD/ Estimated Technology Readiness[2]
Cost, power consumption, the radiation hazard or the size and weight of the dense shielding required, safety, sensitivity and the practicalities of deployment are important issues. Expensive detectors and high-intensity neutron sources must often be used to assure adequate sensitivity. Depth of penetration has to be carefully assessed, as well as minimum amount of detectable explosive. TNA is relatively slow (second or even minute response times). FNA is usually far more complex and expensive than TNA. The complex spectral background due to soil has also to be considered. Soil and other background signals can overwhelm the target signal. Not specific to explosive molecule (unlike NQR).	Neutron analysis systems could typically be combined with other sensors, and be used in a confirmatory role, in particular for the detection of anti-tank mines on roads. It remains to be established if such a system will be practical and fieldable, and if the added performance will be sufficient to justify the extra costs even in specialist applications. Estimated Technology Readiness: (mostly) Medium.
Image processing capabilities can be crucial; large amounts of data. It can be very difficult to differentiate a mine from the background (in particular AP mines) due to low contrast and the presence of highly textured backgrounds. (But this does not necessarily represent an insurmountable obstacle to the detection of minefields as a whole.) Some imaging results can depend quite heavily on environmental conditions, and degrade with increased mine emplacement time. Expensive hardware and infra-structure. Setting-up a measurement campaign can be quite complex.	The focus of remote sensing for HD applications has moved over the years from the detection of individual mines (e.g. from IR images) to mapping/ identification of suspect areas and minefield delineation for area reduction and clearance planning, via the detection of direct and indirect "minefield indicators" (e.g. changes in infrastructure and agricultural land use, minefield fencing, trenches, paths, detours, etc.), combined with collected ancillary information and prior knowledge/intelligence. These applications have a very high potential for HD. Estimated Technology Readiness: High.
Risk: combining insufficiently mature sensors can yield an even more complicated problem than pushing individual sensor technologies up to their intrinsic physical detection limits. Sub-optimal sensor fusion if introduced too late in a system's development. Increased system, and performance evaluation, complexity. When using a confirmation sensor, the overall detection probability (PD) cannot be made larger than the PD of the primary sensor.	Most useful if the sensor fusion can guarantee that a MS system at least retains the PD of each single sensor, and moreover reduces the false alarm statistics. And also if the user interface can be kept reasonably simple, as well as system calibration. Possible solution to avoid full data fusion: use one of the sensors as primary detector (typically the MD) and another as a confirmatory sensor (e.g. GPR or explosive detection system).

1. HH: Hand-held, VEH: Vehicle-based, AIR: Airborne; CI: Close-in detection, REM: Remote detection.
2. L: Low, M: Medium, H: High.
3. 1 kHz=1000 Hz=1000 times/ second. 1 MHz=1000 kHz, 1GHz=1000 MHz.
4. Bulk explosive detection techniques a llow the direct detection of a macroscopic mass of explosive material.

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Appendix A

List of manufacturers

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- **MIL-D1, p. 4**

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Ebinger
- **EBEX® 420 H-Solar, p. 6**
- **EBEX® 420 PBD, p. 8**
- **EBEX® 421 GC, p. 10**
- **UPEX® 740 M, p. 80**
- **MAGNEX 120 LW, p. 86**

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Envotech Co Ltd.
- **Apron, p. 136**
- **Visor, p. 150**

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Force Ware
- **Mine Protection Apron, p. 137**
- **Mine Protecton Suit MPS, p. 138**
- **EOD Squad Suit M-98, p.139**
- **Visor, p. 150**

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- **G-858, p. 90**

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•MD8+, p. 20

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•FEREX 4.032, p. 88
•MINE-CAT 4.600, p. 122

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LBA International Ltd.

•LBA 372-DMV2 and LBA 371-DMV1 Demining Vests, p. 140
•Visor, p. 150

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Med-Eng Systems Inc.

•Advanced Clearance Ensemble (ACE), p. 142
•Demining Apron, p. 143
•Lightweight Demining Ensemble (LDE), p. 144
•Visor, p. 151

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•F3, p. 25

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•RAVELIN Demining Vest, p. 147

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Schiebel Elektronische Geräte GmbH

•AN-19/2, p. 28
•ATMID™, p. 31
•MIMID™, p. 33
•VAMIDS™, p. 124

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Security Devices (PVT) Ltd

- **SADEC Apron/SD 450 Apron, p. 148**
- **Visor, p. 151**

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- **Stolar EDIT-3, p. 35**

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- **3D Borehole Radar, p. 95**

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- **VMC.1, p. 38**
- **VMH3CS, p. 40**
- **VMM3, p. 43**
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- **VMR1, p. 116**
- **VMV 8, p. 126**

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Appendix B

Glossary

A	Ampere
ATMID	All Terrain Mine Detector
BAC	battle area clearance
CIMMD	Close-In Man-Portable Mine Detector
CMAC	Cambodian Mine Action Centre
cm	centimetre
CROMAC	Croatian Mine Action Centre
CWA	CEN Workshop Agreement
DRES	Defence Research Establishment, Suffield
EDIT	Electromagnetic wave Detection and Imaging Transceiver
EMIS	Electromagnetic Induction Spectroscopy
EOC	explosive ordnance clearance
EOD	explosive ordnance disposal
GPS	Global Positioning System
h	hour
Hz	Hertz
I	inphase
IPPTC	International Pilot Project for Technology Cooperation
JRC	Joint Research Centre (European Commission)
ITEP	International Test and Evaluation Programme
kg	kilogram
LCD	liquid crystal display
LED	light-emitting diode
m	metre
mA	milliAmpere
MAG	Mines Advisory Group
MEMS	MicroElectroMechanical Systems
MIMID	Miniature Mine Detector
NATO	North Atlantic Treaty Organization
nT	nano-Tesla
nT/m	nano-Tesla per metre
NGO	non-governmental organisation
PC	personal computer
PDA	personal digital assistant
PPE	personal protective equipment
Q	quadrature
RMPA	Resonant Microstrip Patch Antenna
s	second
S/N	signal-to-geologic noise
STANAG	NATO Standardization Agreement
TDEM	time domain electromagnetics

UNADP	United Nations Accelerated Deming Programme
UNAVEM	United Nations Angola Verification Mission
UNDP	United Nations Development Programme
UNMAC	United Nations Mine Action Centre
UNMACA	United Nations Mine Action Center Afghanistan
UNOCHA	United Nations Office for the Coordination of Humanitarian Assistance to Afghanistan
UNOPS	United Nations Office for Project Services
UXO	unexploded ordnance
V	Volt
w	watt

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